PROCEEDINGS OF THE FOREST INSECT CONFERENCE

BERKELEY, CALIFORNIA

February 5-10, 1923.

UNITED STATES DEPARTMENT OF AGRICULTURE.

BUREAU OF ENTOMOLOGY,

WASHINGTON, D. C.

FOREST ENTOMOLOGY.

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NECESSITY OF FOREST PROTECTION

Prof. Woodbridge Metcalf.

MR. METCALF: I will just take a few minutes of your time in response to the request made of me by the Committee in charge of this Conference that I talk on "The Necessity of Forest Protection."

When that topic was assigned to me I felt a good deal as if it were like, in the old parlance, "carrying coals to Newcastle," or, in the present day terms, "shipping Fords to Detroit," in a body of people as much interested in Forest protection as you are. However, I am glad of the positiveness in the title for the talk -- "The Necessity of Forest Protection" -- because it does imply that we can't get along without it.

Another reason I am glad to talk about it at the present time is because I think we need to talk about the necessity for continued forest protection in California in view of the recent happenings at Sacramento in connection with the Budget. We need to talk about it and we need to emphasize what we feel about it, because our present administration is apparently not convinced at all of the necessity for forest protection.

That some of our leading men in the country are convinced of the necessity for forest protection can be illustrated in the remarks of, first of all, the Secretary of Agriculture, in which he says in a recent address:

> "The timber crop must be protected from fires, insects, fungus disease, just as other agricultural crops are protected. That requires the services of the horticulturist, plant pathologist, entomologist and forest specialist, all specially trained but working together in the closest cooperation."

He is quoted as saying, and I think it is a remarkable statement if he did say it:

> "The protection conservation and growth of our forests are our greatest agricultural problems."

Greeley said:

> "The fact that many lumbermen and timberland owners now recognize that the future use of forest land is to a large degree their problem and not someone elses' problem is in itself a long stride ahead and it is my conviction that the start has got to be the right of the public to tell the logger that the cutover land when he is through with it must be left in a productive condition."

which impires protection.

And, he goes on to say,

> "The cost, should be absorbed as part of the logging operation."

The protection aspects of these statements have a deep significance when one glances over the drafts of minimum requirements for the various forest regions as a result of the Forest Service study along these lines,

without exception, they place the importance of protection measures first. The conclusion is, I think, that if we haven't protection we have nothing. Of course, in many cases we must have something else, but we must have protection first. In our western country this is particularly true as emphasized in connection with redwood regions, but I think it can all be said to be just as true of a great deal of the other forest country.

In this connection, I don't know how many of you have seen the plan for the protection of Pennsylvania forests. Their chief warden, Mr. Wirt, said:

> "The remarkable fact is that wherever one finds valuable tree growth today in Pennsylvania the reason for its existence is not the method of lumbering which may have been conducted on the area, but rather the fact that the area has been kept free from fire. Nature has proved that where fire is kept out continuous forest production is possible under practically all Pennsylvania forest conditions."

I think we can say that pretty well, from our own observations, of a good deal of the western country.

I had a visit a short time ago from the Forester in charge of the Imperial Japanese forests. He was on his way from over a year spent in the forests of Germany, in Europe, back to his own country and had travelled for about two months in the United States. He said to me that the reproduction of forest trees in the United States and Canada is the most remarkable thing that I have ever seen. He said there was nothing like it anywhere else. He said that our natural reproduction is far beyond anything that there was anyplace in the wworld. He said that in Japan they had no such thing as natural reproduction. I asked him "why" and he said that he didn't know; he said they did not have any coniferous or hardwood production. I asked him if he had a fire protection problem and he said that they never had fires. I asked him how he figured that out, and he answered that they had too many people. He said that the people lived close to the forest and put the fires out. But in spite of that, they do not have any reproduction. He told me that the reproduction, particularly in our western country, was astonishing. He also said that he had a better natural growth than he had seen anywhere.

That augurs pretty well for the future of American forestry if we can give the protection and the facilities necessary for such protection.

Turning for a moment to California to emphasize the importance of the forest -- none of the chief functions of the forest can be served adequately without protection, and to summarize them, we have wood in all its forms; a conservation of water, which is to California agriculture perhaps more important than anywhere else in the west; the prevention of erosion; the recreation, which is bound to increase in the future, then, too, the influence of the climate.

Just a few outstanding facts in this connection:

California, as you know, has the greatest body of irrigated land in the world; there isn't any place in the world where such a great body of land

can be irrigated or where such a great body of land is under irrigation as at present in this State. The irrigation expert tells us that 10,000,000 acres of California soil is susceptible to agriculture — I mean irrigation; 6,000,000 acres of that is under irrigation at the present time, or served by present projects. It is far in excess of anything else in the world and it means water. In California, water and the forests are synonymous terms and without protection we haven't got the water.

There are in all about 30,000,000 acres in farms in California. We have a total area of 30,000,000 acres of the State in farms at the present time and only 12,000,000 acres are improved.

There are probably about 30,000,000 acres in forest land and woodland but hardly more than about 15,000,000 acres of the forest land is capable of growing forest crops of commercial size in a reasonable period.

Let us draw a parallel with Mr. Wirt's plan for Pennsylvania. Pennsylvania, with a total area of hardly one third of California, has something like 13,000,000 acres of forest land on which their fire protection plans call for an expenditure of $330,000 per year or about 2½¢ per acre. In thinking of that sum of money, we must consider that this forest is practically all hardwood timber which is much more easily protected than our coniferous stands in the west and they also have a population which is three times in excess of the present population of California, giving them much better natural conditions in the way of transportation and the adjacency of forest areas to labor supply to cut down the fire situation. They do not have such prolonged dry seasons which are an element of our California problem.

If it costs 2½¢ to give Pennsylvania forests adequate fire protection—protection— it is fair to assume it will cost us 3¢ to give California forests as adequate fire protection and probably I have just assumed here that we could probably give them successful protection from other damages for another cent, say half a cent an acre for insects and half a cent an acre for diseases.

Let's see if this is out of the bounds of reason. Considering now that we have 15,000,000 acres of first class forest land, and we have more than that in the state, that is, covered with trees, but 15,000,000 acres of first class forest land at 4¢ per acre per year would give us a total of $600,000.00 per year for forest protection in this state; of that the national government might provide $250,000.00 which isn't much different from what they are spending now; the state $250,000.00 and the private owners perhaps $100,000.00. The private owners are put down as less than the state or national government although they have more of the present stumpage, but even if they did pay in $100,000.00 to protection to the forests it would amount only to a tax of 15¢ per M. on the present cut.

Let's see how this stacks up with the values involved. The value of the stumpage cut each year at $3.00 per M is $4,500,000.00, while the actual value of the total forest production, that is, forest products — and these are dangerous things to deal with because everybody puts a different interpretation on them — let's see as compared with the agricultural products what the production of California products really mean.

Lumber, 1,500,000	@ $40.00	$60,000,000
R.R.Ties, 2,500,000	@ .75	1,875,000
Cordwood, 500,000 to 750,000 cords	@ 10.00	6,000,000
Tanbark, 35,000 cords	@ 25.00	875,000
Miscellaneous (Posts, stakes, poles, charcoal		1,000,000
Grazing, 25,000,000 acres	@ 10.00	2,500,000
	Total	$72,250,000

This isn't a great deal as compared with some of the agricultural crops. As you know, the fruit crops in California far outweigh any other of our crops in value. The hay and forage crops are worth somewhere around $100,000,000 in the state and the fruit crops are worth four times that sum so this isn't a very large amount agriculturally speaking.

Let's take this same $72,250,000 and compare it with the $600,000 that we have suggested as being susceptible of expenditure in protecting this resource and you will see that $600,000 is 8/10 of 1% of this annual return from the forest lands in the state.

Now if we had $600,000 to spend for protection every year in California, and I think we are going to have it some day soon, how would we spend it?

National forest fire protection, probably	$250,000
State forest fire protection including cooperative funds from 30 counties at $2500 - $3000, or $7500 - $9000	250,000
Insect and disease control projects (field)	50,000
Investigative work in entomology and pathology at Forest Experiment Station, at the University or in cooperation therewith	50,000

Now, $600,000 spent in that way, what would the dividends be? As we see it, it isn't much, just 8/10 of 1% of the annual resources that come from the forest and that certainly ought to enable us to make progress along protective lines without which we won't long have very many forests to protect. (applause)

FORERST INSECT CONTROL THROUGH MANAGEMENT

by

J. C. Evenden.

The purpose of this paper is to present the possibility of controlling forest insect infestations by logging, or rather by forest management. This subject, which could perhaps be better titled as "Forest Management for the Control and Prevention of Losses by Forest Insects," is a problem for the forest lumberman as well as the entomologist. The losses within our timber stands should not be considered as lying wholly within the province of entomology, but in the same light as planting, timber sales, fires, etc., with the ultimate idea of utilizing all these phases of our national forests.

The success which would be realized from the adoption of silvicultural regulations for the prevention of losses within our timber stands from Dendroc tonus beetles is not known. Just what regulations could be adopted we do not know, for there is yet a great deal to be learned relative to the habits of the Dendroctonus beetles, and I assume, the growing of our future forest as well. However, it may be possible that with the development may be discovered which may prove to be of assistance in minimizing these losses.

In a paper read before the Woodland Section of the American Paper and Pulpwood Association Dr. A. D. Hopkins, Forest Entomologist, U. S. Department of Agriculture, called attention to the adjustment of forest management to avoid losses from insects which make their principle attack on merchantable sized trees. He concludes that "... the key to the future successes in preventing serious losses from forest insects is to be found in the management of the growing timber and its utilization when the crop is ready to harvest." Dr. Hopkins, no doubt bases this principle upon the fact that certain of our destructive insects, as a general rule, will not attack trees below a certain diameter limit or period of maturity which carries with it a lessening of their resistence to insect attack. Its application would depend upon the establishment of a rotation period for the growing of our timber supply which will allow the trees to become merchantable, but still not be suited for insect attack.

The success of the application of such a principle in our western forest for the prevention of losses from the attacks of Dendroctonus beetles is problematical, as we have no information relative to the effects that the practive of intensive forestry will have upon the habits of these insects. Should we accept for a working basis the theory that, as a general rule, only the larger mature trees are attacked by certain of our destructive insects, what assurance have we that these habits will remain unchanged when no such host material remains. My observations have led me to believe that with both yellow pine and white pine Dendroctonus beetles are perfectly able and do attack and destroy young vigorous trees. However, thought should be given

to this phase of forestry in the hopes that in the future some means of management may be found that will minimize these losses through its application.

Though it is realized that the possibility of adopting regulations for the protection of our future forests is still a problem to be solved, it is believed that consideration should be given to our present stands with a view of preventing further insect damage by the marketing of mature stands. The present silvicultural plans of the Forest Service towards bringing our forest under sustained yield, is understood to be the removal of the mature stands, where the annual losses equal the annual increment, with the idea of replacing with thrifty growing stock. In the determination of a mature stand the annual insect loss is an important factor.

As yet no attempt has been made to control the endemic infestations which exist in nearly all of our pine forests. These so called normal infestations are apt to be regarded too lightly, or the scattering infested trees throughout a forest overlooked entirely. The losses from these endemic infestations, though perhaps small per year, amount to a large volume if taken in the aggregate. Perhaps the institution of actual control measures for the prevention of these losses will prove to be impracticable and uneconomical, but the early marketing, if possible, of this timber would result in the prevention of further losses by insects and other agencies, the reduction of the infestation the securing of a greater volume in some species, and a greater opportunity of securing a better restocking of the commercial timber species cut.

In the Journal of Forestry (Vol. XVIII. No. 4) April 1920, Mr. W. J. Pearce, Forest Examiner, D-2, writes of the insect damage in three National Forests in Colorado as follows: "Yellow pine of the size and quality found on the project is usually about 300 years old. The loss from insects during the life of the stand can therefore be obtained approximately by multiplying the loss attributed to 25 years by 12, which gives 264,000,000. The volume of standing green found on this area was 292,000,000 feet, and the difference 28,000,000 assuming that the present stand represents the average growing stock that has existed on the area, may be charged off as losses resulting from fungi weakened trees blowing over, trees destroyed by the mechanical action of lightning etc. In other words, during the life of the stand 90 percent of the trees by volume will be killed by insects and 10 percent by other causes." The interpretation which is placed upon this datum is that during the life of the stand (300 years) a volume equal to that which remains has been destroyed. If this is accepted then our present yellow pine forests are mature, and have been for many years, for though larger trees will be secured there will be no increase of volume. Following this theory we find that, as a yellow pine stand perpetuates itself, though there has been no increase of volume there has been no loss as the entire forest has been at a standstill.

The datum given by Mr. Pearce can not be applied to white pine forests. Throughout these forests the white pine trees killed each year by insects and other causes, aside from large openings from fire, are replaced by species of a lower commercial value of which a large percent is hemlock. A re-stocking of

white pine can not be obtained without a complete opening of the forest canopy. Given an equal chance with light, white pine will easily suppress the other species which go to make up the characteristic white pine type. So in a white pine forest when a loss in white pine volume is incurred through insect attack, it must be balanced against the annual increment of the remaining volume as there is no understory of this species to profit by this gradual thinning.

The following figures are given showing the percent of annual increment to white pine within the Coeur d'Alene National Forest which are believed to be fairly representative of the entire white pine belt:

Age of Stand		Annual Increment.
81 - 100		.0157 of volume
101 - 120		.0120 of volume
121 - 140		.0120 of volume
141 - 160		.0119 of volume
161 - 180		.0065 of volume
		5.0581
	Average.	.0116

Mr. P. Neff, Lumberman, Coeur d'Alene National Forest, in a recent memorandum gave the losses resulting from the normal infestation which exists in the white pine stands of that forest as .005 of the total volume. If we take this figure, which I concur with, and charge it to the annual increment there will remain only .006 which must carry all insect epidemics, fungi attacks and windfalls. It is believed that if these figures could be accurately determined it would be found that our white pine stands are mature many years before they are now so considered. Besides the loss of white pine volume, a greater stocking of the stand with the less valuable species by the partial opening of the canopy is provided for. This material, which is mostly all hemlock and of little value, must be disposed of at the time of logging in order to permit the white pine seedlings to secure an equal chance with the other species. The disposal of this material only, which consists of the girdling of a certain percent, and the felling and burning of the remainder, costs approximately $6.00 per acre, besides increasing the fire risk.

To summarize this discussion it can be stated that an attempt has been made to show that in many of our forests the expectation value due to the annual growth is nearly equaled after a certain period in the life of the stand by the losses due to insect attacks.

To show that in the Inland Empire some of the private operators are attempting to reduce insect epidemics in their holdings by the adjustment of their working plans a brief discussion of the Boise-Payette Project follows:

> During the winter of 1921-22, by correspondence and conferences with Mr. H. C. Shellworth, Land Agent, Boise-Payette Lumber Company Boise, Idaho, an examination to determine the present status of the forest insect infestation within the Payette River drainage was planned. This examination took place in May 1922, and covered National Forest lands as well as those of the Boise-Payette Lumber Company.

Throughout the timber stands examined the infestation was at a very normal status, with the exception of one region where an epidemic had been in existence for the past five years. In a rather small area owned by the Boise-Payette Lumber Company, which supported a stand of at least 12,000,000 b.f., approximately 17% had been killed by the western pine beetle. This epidemic was purely a center of infestation from which the beetles were extending their activity further each year. The source of this epidemic was apparently the slash, and the method of logging followed in a logging operation of a small locally operated mill.

Inasmuch as this area was purely a center of infestation with no other epidemics in the same unit and that its scope was broadening each year control measures were recommended. These recommendations carried two methods of combating the epidemic which were the actual control measures which the Bureau of Entomology is using in the southern Oregon project, and the logging of the area under certain regulations at the close of the operation. Due to conditions which were peculiar to this region which made it possible for them to do so, it was decided by the general manager of this company that it would be more economical to log the area than to institute actual control measures, through additional expense would be incurred in going ahead of their plans fully ten years.

The estimated volume which would have required treatment during the present winter was 250,000 b.f. which would have entailed an expense of approximately $1250.00. As a result of logging at this time a salvage of insect killed timber amounting to 420,000 b.f. at a reduced stumpage price of $2.00 which amounts to $840.00, will be made. Just what percent of the additional expense of logging at this time this amount will compensate is not known.

The success of this project, as with any logging operation for this purpose, will be the <u>clean up</u> at the close of the cutting.

At the close of a logging operation in yellow pine which has been for the purpose of reducing an epidemic of the western pine beetle the following rules should be observed:

I. At the close of the operation a proper disposition of all chuncks, cull logs, and large tops should be made as follows:

   a. This material should be peeled and the bark burned after the beetles have attacked and before they emerge. (This of course, if there has been an attack).

   b. Piling slash upon this material and <u>severely</u> scorching after the attack.

II. A sufficient number of freshly cut logs, acting as traps, should be left in the woods until after the next attack of the beetles had occurred, when they should be removed and placed in water, or the bark peeled and burned. This would not be necessary if there was no infestation in the adjacent timber or the beetles were not in flight.

III. The year following the close of such an operation a careful check should be made of the surrounding timber stands and any infestation appearing should be promptly treated. This

could occur by the beetles being attracted to the operation at its close, and there being no down timber to attack.

It is believed that if the rules as given are observed, which are possible for an operator to comply with, that logging operations within yellow pine stands will prove to be a benefit in the reduction of any surrounding infestation, and not the menace which they are sometimes thought to be.

James C. Evenden
Entomologist.

MR. WOODBURY: I endorse Mr. Evenden's theory. The theory seems to check out with the cases that I am familiar with.

MR. BURKE: It seems that that is a special case, that is, where the logs lie in the woods all summer. In the average logging operation they wouldn't be left lying that way; they would be hauled out and milled.

MR. EVENDEN: There are many sporadic logging operations in the Northern part of the country -- we call them "Jipo" -- which are of that nature. They will log in the early spring when the skidding is good and leave the logs until fall when it becomes good for trucking and then they will haul out the logs.

MR. BURKE: In regard to the original, or first infestation that we know of, we figure that it may have happened the same way. I know up where we worked for awhile there were small logging operations and they handled their logging the same way at that time. I don't know whether that was the cause, though. One of the companies had built a new dam and there had been a good deal of cutting and no milling and it may possibly have been that there might have been an endemic infestation throughout the forest and that might have caused some of this trouble.

MR. WOODBURY: Is that in the same region?

MR. BURKE: Yes.

MR. METCALF: I don't know whether you remember, or whether you have mentioned the Del Monte property infestation -- that occurred in the same way. Land prices soared; that location is the best for home site purposes, the most valuable, of any place in California. The Del Monte Corporation has been trying to clean up that area; as the lots were sold they cut the trees down and pulled them up for work. During the last two years there has been a very serious infestation of the Red Turpentine Beetle and two species of Ips. They spent $60,000 in attempting to clean it up this year on that property and have made very little progress because they haven't had full cooperation. You know that the Red Woods are not very often attacked by insects of any kind, but I found in the Eel River this last spring a good many Redwood sprouts less than five years old which were killed by a species which do not attack living trees at all but resulted in that case from the piling of cordwood by donkey engines which got the infestation well started and they took the cordwood away and they went into the sprouts and you could see brown sprouts all through the area where they were killed. In both cases it was that sort of thing that caused it.

CHAIRMAN: I do not think that insect epidemics of the Western Pine Belt would be created from limbs and tops left around through the woods because the bark is not sufficiently thick enough for them to breed in.

MR. BURKE: There are two reasons for this situation: One is that the cutting of the stuff attracks the beetles from all over the area ~~dx~~ and the other, of course, is where the broods breed in the limbs and tops and attack the trees after they emerge. The effect is the same.

CHAIRMAN: The insects have always attacked the down material first.

MR. BURKE: If you could sttract them in there wouldn't that be of some benefit?

CHAIRMAN: Yes, if we could get them in and treat the slash it would be a benefit.

MR. BURKE: Instead of treating the slash immediately or burning it you should wait until all the bugs get in there.

MR. WOODBURY: I understand it is thought by Mr. Evenden that Dendroctonus brevicomis didn't breed in slash and tops. Sometimes we had a contract clause that required the piling of brush over the tops; the theory was that the tops were used as breeding places, but we have now concluded that probably that measure is not worth while because they don't probably breed in the tops. We have cut that clause out of our contracts.

MR. WOODBURY: I think there is no question about the damage that insects are doing in the pine belt; in fact, it is more damage than is being done by fire and that ought to argue well for a modest budget for insect control work such as Mr. Metcalf suggested at the start.

FUTURE COOPERATIVE CONTROL PROJECT ORGANIZATION

by

T. D. Woodbury - Assistant District Forester.
Dist. 5,- U. S. Forest Service.

For the past fifteen years I have been vitally interested in all factors affecting the welfare of the forests of California. The problem of insect control during this period has been one of the most interesting and yet one of the most baffling with which I have had to deal. It has been a football for theorists, and a favorite bone of contention among Foresters, Lumbermen and Entomologists. We can see and ascertain readily the amount of damage done by our little copper colored enemies, but just why they wax fat and prosperous during one brief period and then decrease in numbers just as rapidly has been a problem that we could not solve. Without knowing the strategy of our enemies our attacks have naturally been rather feeble and sporadic. The results of these attacks have often been difficult to appraise. We have frequently been obliged to content ourselves with the simple argument that since the damage was caused by certain types of beetles the more beetles of this type we could lay low the less would be the damage. Although it is difficult to find a weak spot in this theory as a practical matter it has not always stood the test. After a particularly vicious assault the beetles have occasionally responded with a counter offensive which has left us weak, baffled, and almost defenseless. It is this uncertainty as to the habits of the beetles and the effectiveness of the generally accepted methods of control that has caused a considerable group of foresters and timber owners to question the wisdom of spending large sums in insect control. Confused by numerous theories, none of which could be made to fit the facts in all cases, they have resigned themselves to what they have considered a certain inevitable loss; just as one becomes reconciled to the results of the operation of certain laws of nature.

While this attitude is perhaps natural it cannot be tolerated by any who are charged with the protection of our forests. Each defeat should stimulate our determination to solve the problem of the habits of our enemy and to work out an attack which will hold the damage done down to a minimum which will not be a serious drain upon the forest.

The cooperation and support of all those who have interest in our forests, financial or otherwise, is necessary to success in this campaign. It is said that it is always easiest to secure union and harmony among common interests when danger threatens. If this is true it should not be difficult to present a united front at this time for without doubt there has been more damage done by dendroctonus in California during the past year or two than ever before in my experience. I am not going to quote you any figures to prove this because they are uninteresting and because I did not have time to dig any up but I know from field observations and from reports which come over my desk that we are suffering unusually heavy losses on the National

Forests of the northern half of this state, notably in the California, Shasta, Modoc and Lassen Forests. The infestation on the California is particularly disturbing because the groups of dying trees are unusually large.

So much for the conditions which exist, now what future action is necessary in order to make the cooperative campaign of forest owners against their common enemy most effective? Three lines of procedure are clearly indicated - experimentation, education, and legislation. I place experimentation first advisedly. Before we can spend money in insect control to the best advantage we must know more of the habits of the beetles as has been pointed out. We must know how far they fly and what barriers they can overcome before we can lay out the boundaries of a control project intelligently. The Forest Service and the Bureau of Entomology are now working on an experimental project on the Santa Barbara Forest which should give us at least a partial answer to this question. Other experiments under other conditions will, however, quite likely be found necessary before the final colution can be arrived at.

We must know the numbers of broods of the various beetles to be expected annually under various sets of conditions so that our control work may be properly timed. The Bureau of Entomology has a good deal of information already on this important point but the range of conditions is so wide that this field has not yet been thoroughly covered.

We must ascertain the effectiveness of and best methods for conducting maintenance control. This is the principal object of the San Joaquin Control Project on the Sierra Forest, the details regarding which have already been presented in another paper. It seems unwise to spend a large sum of money in control work on an area for a year or two resulting in a good clean up and to then cease work allowing the beetles to again become numerous and destructive. The ideal is continuous vigilance and a measure of control over all forested areas that will prevent epidemic infestations. If this system of maintenance control is to be instituted it must be shown that the timber saved by it will be at least equivalent to the cost of the work. This involves careful experimentation to devise and put into effect new and economical methods of control such as sun-killing, trap trees, etc., and a careful study of check areas to determine what probably would have happened without control. Due to the resourcefulness and perseverance of Entomologist Miller encouraging progress toward the solution of this problem has been made. This project is of far-reaching importance and must be supported by all interested agencies. It will be supported during the coming year either from the special appropriation for the Northern California-Southern Oregon control work, or from a regular Forest Service appropriation for insect control.

Another broad line of experimentation that should be carried out is the determination of the role played by birds and predatory insects in the control of infestations and the working out of methods for using these agencies effectively. At first thought this line of experiment does not appear very promising because of the natural conditions in the forest unfavorable to the successful artificial protection and propogation of these helpful forms of life. However, the effort is worth while and I am glad to know that experimental work along this line is contemplated by the Bureau of Entomology.

These are only a few of the experiments which suggest themselves. The field is large. Control work cannot await the results of these experiments when large values are being lost annually. Experimentation should proceed side by side with control. Each large cooperative control project offers a field for experiment. An investigator should be a part of the personnel of each project and funds and means should be provided for making his work successful. He should be responsible for seeing to it that new methods tried out which give fair promise of success are adopted in the control technique. This phase of the work is one which the Bureau of Entomology is eminently well fitted to handle.

Next to experimentation the most vital factor contributing to the success of control work is education. This has several phases. Land owners must be educated in the habits of the beetles and the destruction done by them before they will loosen their purse string and give the financial aid so vital to the success of every cooperative project. I imagine that our friend "Jack" Kimball could write an interesting text on this subject after his experiences with the land owners in the Northern California-Southern Oregon project. This work requires diplomacy and skill and must be given considerable attention by some well qualified person in connection with each project. In this line of education the personal verbal appeal is most effective, laying stress on the timber loss in money values. The next best thing is the personal letter appeal with repeated follow ups.

The general public must be educated for a public sentiment is necessary in order to stimulate land owners into action and to secure general legislation when necessary. For this purpose the two most effective mediums are the moving picture and the daily press. We must give very much more attention to this line of publicity. An effort should be made to secure a film of the work done on each large project - for exhibit throughout the State. The Forest Service has had considerable success in securing the running of Forest Fire films at local theatres and it is felt that considerable good has been accomplished by this means of publicity. The preparation of regular news items regarding the project work should be the duty of the best adapted member of the personnel. The Chief of the Office of Public Relations in each Forest Service District Office can render valuable assistance in this line of educational work by dressing up the news items and putting them in the best channels for effective circulation.

Next the men who work in the woods must be educated to detect insect damage from the various types of beetles readily, must know the habits of at least two or three most destructive beetles and must understand the generally accepted methods of control. Here the Forest Schools have a distinct duty to perform. Each Forest School gives a course in Forest Protection but so far as I am informed the subject is very largely confined to protection from fire. <u>To my mind the fire problem is much nearer solution than the insect control problem. The damage done by insects annually, while not so spectacular as that done by fire, is larger.</u> This would argue for a more important place for insect control in the curriculum of Forest Schools. A brief course of lectures by a practical entomologist is indicated as a part of the course in Forest Protection to be supplemented by fyeld work in identification of insect work and in insect control. A number of lumber companies are now employing technically trained Foresters. Not long ago a leading California lumberman made the remark that within the near future every important lumber company in the state would have a Forester in its

pay roll. When this time arrives if these men have an adequate knowledge of forest insect control the interest of these companies can be more readily secured in connection with cooperative projects and they will also be in a position to handle such work effectively and intelligently on their own lands. Many of the National Forests now have at least one Forest School graduate on their staff. At present these men with but few exceptions must secure all of their training in practical entomology after entering the Forest Service if at all. The opportunities for securing such training on the forests are limited and as a result infestations are frequently overlooked and needed control work is not performed. One trained technical man on each Forest could educate the ranger force in control practice and considerable maintenance control could be carried on by them on their districts as a part of the general protective scheme.

I am looking forward to the day in the Forest Service when every Forest Supervisor will be as alert and well informed regarding insect injury and the need for and methods of control as they are now regarding fire. This attitude and knowledge will have been passed on from the Supervisor and his technical assistant to the ranger. The ranger in turn will each year report insect conditions in his district as he now reports grazing and fire conditions. Needed insect control will be shown in each Supervisor's allotment estimate. The District Forester will receive an allotment for insect control as he does now for fire control. This will be apportioned to Forests according to needs and at the appropriate time of year the necessary control work will be performed by a control crew working under the ranger's direction. When this much to be desired time arrives we shall certainly have old man John L. Dendroctonus on the run. Before that day arrives we have a good many rivers to cross but a liberal education all along the line as outlined above will help tremendously in reaching our objective.

Everyone who has had experience in organizing cooperative effort has come in contact with the fellow who hangs back for one reason or another. Sometimes he pleads poverty, sometimes he is indifferent, sometimes he is ignorant, and sometimes it is just plain cussedness. This individual is responsible for the laws that cause us all so much trouble. If he would only act in accordance with the best interests of the group, or in other words cooperate, we would not need our laws and we could use the lawyers in insect control work where they would do some good. Now, when we start a control project on a big scale we must cover the entire area with our control or the untreated area will act as a center of infection and undo our work. If education and persuasion fail the unwilling owner must by some means be forced into line or the willing owners must do his work for him which does not appeal to our sense of fairplay. Time and again here in California the willing cooperators have performed control on the lands of the unwilling fellow and nothing has been done about it. It is different in Oregon. They have taken the lead there just as they did in connection with slash disposal and have secured legislation which is now being tested in the courts and which is designed to secure 100% cooperation in connection with ~~xkxskx~~ all insect control projects. Doubtless you are all familiar with this legislation, in brief it provides for the creation of insect control districts. Insect infestation on any ownership by the State Forester and the institution of control measures within the district when desired by the owners of 60% of the land in the district may be declared a nuisance by the State Forester and if not abated by the owner the work may be done by the State Forester in which event the cost

of the work becomes a lien on the land. California land owners are now thoroly alive to the desirability of such legislation here in order that cooperative control may be successful and similar bill will be introduced at this session of the legislature. This bill has the endorsement of the lumbermens associations, the State Board of Forestry and the Forest Service. There is no organized opposition to it so far as known and it should pass.

To sum up: Insect control project organization of the future should comprise provision for experimental work by a trained entomologist or entomologists, and the prompt incorporation of the results of experiment into the plan of control. The project plan should provide for maintenance of controlled conditions after the first clean-up has been made.

Education of the public, of timber owners, of forest managers and legislators is essential in order that the importance of insect control may be recognized and provision made for carrying it on energetically and skillfully.

State legislation must be secured in all states where insect control is necessary in order that infested areas may be cleaned up satisfactorily and that owners who are willing and desirous of protecting their forests may not be prevented from effectively doing so by the few who are unwilling.

I look for an increasing appreciation of the necessity for control on the part of land owners, for closer and more effective cooperation in control among such owners, for a constant improvement in the technique of control brought about by intelligent investigation. Insect control work will, in my opinion, soon come to be recognized as a necessity among owners of pine stumpage and the cost of control will be taken into account as a carrying charge just as fire protection now is.

DISCUSSION:-

MR JAENICKE: Mr. Woodbury has, unwittingly, I think, made some of us realize our shortcomings. Unquestionably those of us who are engaged in a special line of work are overlooking the importance of letting the other man know what we are doing. We can't expect help of those who are in a position to help us unless they know what we are doing unless those around us know of what we are trying to accomplish. That is as true in control work as it is in experimental work and again and again opportunities come to us to make better known the insect control problems and, because we think we are too busy, we overlook this chance to make better known the work we are doing. Isn't it time to put our bug data in such shape that it can be used in the newspapers and timber trade journals? We can at least turn in the stuff we have in some form and let the publishers re-vamp it in the way they think best. At any rate, we ought to be more alert to the opportunity to make the bug work better known. I think we have the full responsibility on our own shoulders.

THE CHAIRMAN: I received a copy of the Forest Ranger from District No. 6, and it seems to me with that man on the job you have a good chance to get some publicity in that way. It is a splendid way to get the necessary publicity for these things.

MR EDMONSTON: Our great difficulty is to write this stuff in such a way so the public can understand it.

THE CHAIRMAN: The present organization of the Public Relations Department will help; all you have to do is to turn it over to that department and they can put it out.

MR JAENICKE: From my own experience it isn't necessary to put this stuff in final shape. The editors have their own ideas about such things and frequently edit our most carefully prepared data.

MR EDMONSTON: I agree with Mr. Jaenicke and know that the papers are always glad to get something. My only suggestion is that you write the article yourself and secure their promise to put it in that way.

MR HERBERT: There is a decidedly lack of literature in another way, not only in the newspapers, but for future study in entomology by students. We expect them to study without having any literature to base their studies on. It seems to me that we should do more along that line.

MR METCALF: This meeting has a great deal of publicity value. I don't know whether you saw it or not but I wrote a notice about this meeting and I saw it in two of the papers. I sent a little item through the Dean's office and it went through in the regular way. You know we are under limitation so far as items for publication are concerned, but we can do what we can. Another good medium of publicity is in the pictorial sections that the big newspapers are putting out. Some get them out every day and some make magazine sections out of them. They are glad to take pictures and if you can get your message with them most everybody will look at it. Of course if you could get something in the New York Times or in the Chicago papers it would be great.

THE CHAIRMAN: Mr. Evenden will cover the subject "Experimental Needs" in place of Mr. Miller.

EXPERIMENTAL NEEDS
by
J. C. Evenden.

MR EVENDEN: I can only touch upon this subject in its broadest sense. Many people believe that the Bureau of Entomology is satisfied and that we are resting securely upon our oars and are making no effort to improve our methods. Contrary to that belief we realize perhaps a great deal better than those who criticise us that there is yet a great deal to be known relative to forest insect control. In our control methods of Dendroctonus epidemics we have been accused of using methods which are inadequate, crude and inefficient, in fact many unkind things have been said about us. In answer to that charge all we can say is that we are using the best nethods known to us at this time, and that we are applying them to the very best of our ability. Aside from that we can make no answer. It is further realized that methods may be developed which are entirely foreign to any which are used at this time. Aside from the possibilities of future investigations there is further field for investigation in the application of the methods which we have at this time and I would like to touch briefly upon some of the most important of these.

A problem which we are facing at this time is the time to institute control measures. Some feel that control measures should be used for endemic infestations and others feel that it does not pay to control such infestations and that we should wait until we are suffering serious losses. We must know more of the causes for the increases and decreases through natural agencies in order that we can successfully inaugurate control measures.

The host selection principle, whereas it is believed that Dendroctonus species or an insect breeding in one tree species, after becoming adopted to that host will not leave and attack another is yet to be proven by a thorough application of that method. We need an actual field test in order to prove the truth of falsity of this principle.

The percentage principle is yet to be thoroughly proven to the lumbermen and foresters. No matter how we as forest entomologists think, we have yet to secure evidence whereby we can apply the percentage principle thoroughly and conclusively.

Relative to the relation of fire and insects, or the part that fire plays upon future endemics, there is yet a great deal to be determined. Perhaps in some species of timber a great deal of information is now available, but with other forest types and insects we know very little.

The relation of logging slash to insect epidemics is a problem yet to be definitely solved, though many of us perhaps have our personal ideas, but they are yet to be proven for the many forest types and conditions. We have yet to learn if the weakening of a forest tree by defoliation provides favorable host material for Dendroctonus beetles. Mr. Miller has told us that we have yet to prove the worth of maintenance control work. So, in all, we are not nearly satisfied; we are not resting upon our oars but are always trying to secure more information which will be of value to us in solving of forest insect problems. However, our time is so taken for cooperative work that we have but little time for investigations.

Aside from Dendroctonus beetles there are other bark beetles which are often of economical importance and of which we know but little. The Ips, though regarded as secondary in character, often develop into a primary enemy of our forest and destroy large volumes of timber. Information must be secured relative to their seasonal history and methods of control. And so on with other species, we must study them, know their habits and be ready to meet an emergency when it occurs.

Last, but not least, comes our shade tree problems. The shade tree investigation is included in the branch of forest entomology although I am not well enough versed to speak upon the problems, we know that Mr. Burke is putting a great deal of time in the investigation of shade tree problems.

In the Glacier National Park during the past season a problem has arisen which will require an investigation before recommendations can be made, as this is purely a standpoint of scenic beauty.

I have tried to outline the position of the Bureau relative to what we consider some of our most important needs in investigation and emphasize the point that we are not sold to our methods which we are using now.

I wish to say that all we ask as Bureau officers is that the lumbermen and the Forester all bear with us during our experiments, as they are doing at the present time, for we are doing our very best and with their help some day the best methods will be obtained. To do this money must come from somewhere for us to test our theories and principles, for as theories nothing further can be learned until they are put to actual test.

I thank you for your attention and I apologize for this paper for as I only prepared it on short notice I could only cover the subject in a general way. (Applause)

MR JAENICKE: Mr. Evenden has effectively brought out the urgent need for immediate study of a number of a number of most important problems. However, I think Mr. Evenden has overlooked just one matter, and that is the desirability of making our data available to the public as soon as it is reasonably conclusive. Only in this way can we secure financial support of our work, and bring about the widespread adoption of beetle protection in the forests.

THE CHAIRMAN: That is a good idea and that point is well handled in Canada by literature of importance being sent out on these various subjects.

MR WOODBURY: I think it important to the Bureau and to the public and this information could be published in some of the lumber journals to good advantage. The Forest Service gets reports published that way.

SUMMARY OF IMPORTANT POINTS BROUGHT OUT
IN CONFERENCE

D. Brevicomis

Seasonal History and reference to Bioclimatic law.

1. Plants and insects respond at about the same rate to climatic influences.

2. At Ashland there was a marked variation from the theoretical constants of the Law in comparing lower and higher elevations; between 3200 and 5700 theoretical difference of 25 days, actual difference of 50 days probably due to retarding influence of snow.

3. D. brevicomis is extremely sensitive to temperature. A low temperature probably 50° F. where activity ceases, also high point about 100° F. where activity ceases.

4. A marked difference found between the north and south sides of infested trees in rapidity of overwintering brood development. South side 35.4 days earlier than north side. Summer generation trees develop more uniformly.

5. Number of generations vary for different localities from one to three generations a year (see table).

Bark Counts

See Table #2.
No conclusions reached as yet as to the significance of bark counts, except that during the endemic infestation the counts appear to be lower than for epidemic infestation. Attacks per square foot are practically constant for all types of infestation.

Natural Control

Extreme heat and cold have been found to kill insect broods but these factors can not be relied upon in establishing control in nature.
There are not many species of parasites and predators. They are found in greater numbers following an epidemic infestation when the infestation is becoming endemic.
Woodpeckers work to better advantage when the infested trees are not plentiful.
Night hawks have been found to feed upon Dendroctonus.

Flight Habits.

Evidence by Patterson shows that beetles flew for at least $1\frac{1}{4}$ miles and attacked a trap tree in great numbers.
Evidence on the Southern Oregon-Northern California project for 1922 indicates that the influence of control work was limited to the area on which the work was done, which would tend to prove that at this time there was no general shift or migration of the infestation. Group infestation on many projects surrounding old loss would indicate the localized character of the infestation.
Evidence on the Antelope project showed a general decline throughout the area following control work on one portion, but there is nothing to show that the general decline was from natural causes tather than from the effect of the control work. (Not well taken - I consider the decline due to the control work. - Patterson)

Dendroctonus brevicomis confines its activities to certain ranges in elevation which correspond to the yellow pine belt, which at Klamath Falls, Oregon is between 3000 feet and 5500 feet. In traveling it appears to follow around on the contour instead of crossing over divides.

Attraction to host

A tree in the forest was selected and the lower portion caged and Dendroctonus beetles liberated in the cage. These beetles attacked the tree and within four days beetles were attracted to the rest of the tree and the tree killed. Predators arrived at the trees as soon as the attacking beetles.

A tree in the forest 1 mile from the nearest infested tree was similarly caged but the beetles within the cage failed to kill the tree and no beetles were attracted to the outside, although Clerids were found. This would tend to show that the attractive influence of a tree being infested did not extend one mile.

Trap trees.

Felled trees under normal forest conditions with an endemic or epidemic infestation absorb heavy broods. If the attack is soon after the tree is felled a low mortality in the development occurs. Clerids and Dipterous parasites arrive before the beetles.

Attraction to traps is greater than that to standing trees.

That very few traps load heavily where a large amount of trap material is available.

That brood mortality is approximately 74%, where the traps are numerous.

That is used in control work the number of traps cut should be governed by the amount of infestation in the area.)approx. 25% of the infestation in standing trees)

Trap trees cause a centralization of infestation which often goes in and kills adjacent standing trees. (This is also true of W.P.)

Summer trap trees felled in June loaded better and peeled more easily than fall traps felled in September.

Attempts to plant infestation in timber below the general pine belt were unsuccessfull.

TABLE I.

SUMMARY OF SEASONAL HISTORY OF D. BREVICOMIS

Locality	Lat.	Elev.	Exposure	Year	First Activity	Last Activity	No. Active days.	No. of generations per year. Min.	Max.	Aver.	Period for Control Work From	To	Rem.
Klamath Falls		5000	South	1922	Apr. 18	Nov. 18	210	1	3	2	Oct. 1	June 1	
"		5000	North	1922	May 1	Nov 1	180	1	2	2	Oct. 15	June 15	
N. E. Oregon		4500			Apr 5					1		June 15	
Coeur d'Alene		2300	South	1922	May 1	Nov 1	184	1	2	2			
"		2300	North	1922	May 8	Sept 20	166	1	2	2			
Ashland, Ore.		2500	South	1922	May 15	Dec 1		1	3	2	Nov. 1	May 1	
"		2500	North	1922	Apr 1	Nov 1		1	3	2	Oct 15	May 15	
Northfork, Cal		4000	South	1922	Mar 15	Dec 1		1	3	2	Nov 1	May 1	
"		4000	North	1922	Apr 1	Nov 15		1	3	2	Oct 15	May 15	

SEASONAL HISTORY WITH REFERENCE TO VARIATIONS UNDER THE

BIOCLIMATIC LAW.

by

J. M. Miller.

One factor which makes it difficult to harmonize brood records with plant growth and other phenomona relating to the bioclimatic law is the extreme sensitiveness of the barkbeetles to temperature. There is a certain low point of temperature, not yet determined, but probably around 500 Fahr. where activity in all stages of the brood ceases. Just as soon as the temperature rises a degree or so above this point activity begins again. This activity presists as the temperature rises up to about 100° Fahr. where the broods will also become dormant from the effects of the heat.

This sensitiveness to temperature causes a tremendous variation in the development of broods in overwintering trees. In a tree that is attacked in late September the majority of the brood will have reached the half grown larval stage by the time cold weather sets in. Then a constantly increasing difference in development of individuals of the same brood occurs. During warmer clear days bark in the south side of the trees becomes warmed for a few hours to a point which starts activity and the individuals in this bark continue to develop while those on the north side of the tree remain dormant. If a section of infested bark is taken into a warm room the broods complete their development and emerge at the same rate as broods develop in summer generation trees. By spring you will find the broods in bark on south sides of overwintering trees far ahead in their development of those on the north sides of the same trees. As the first warm spring days come on this difference is still further accentuated. As a result we find that emergence on the south side occurs about a month earlier than it does on the north side of the same tree.

Consecutive records kept by Mr. Keen at Ashland in the spring of 1916 from 15 representative overwintering trees show that for all activities from first pupae to last emerging average 35.4 earlier for south sides than for north sides of the same tree.

In summer generation trees broods develop almost uniformily on north and south sides. In both summer and winter generation trees, however, the influence of warmer slopes and exposures is pronounced and for this reason we seldom find any two trees in which brood development is uniform.

From an economic standpoint seasonal history is important in indicating the number of seasonal generations which may develop under the varying conditions of the yellow pine belt. Records from ~~may~~ many trees on the old Ashland areas indicate that here D. brevicomis develops as an average about one seasonal generation and a partial second. This was also found to

be the case from records from the Sequoia National Park, which indicate the same conditions.

Several caging experiments have been tried out at an elevation of 2000 feet at Ashland. It has been found possible, starting in with the beetles which emerge about the middle of May, to carry through two complete seasonal generations and one overwintering generation, the emergence of the second generation occurring after October 1st. In a check experiment carried out at an elevation of 5000 feet, it was possible to secure only one complete seasonal generation in the cage.

It is believed that these cage experiments represent the maximum possible development that it is possible to obtain as there is no period of voluntary flight and the emerging beetles are forced to attack the logs within a few days after emergence. Our field records indicate that there is a much longer period of flight and that while in the warmer regions like the Southern Sierra, there may sometimes occur two complete generations during the summer, the general average is one summer generation and an overwintering generation.

The entire problem of seasonal generations is a decidely complicated one, there being a great overlapping of generations due to variation in development sometimes in the same tree. We tried to check these in our field cruising but finally gave it up as a hopeless undertaking.

We have finally adopted the system of distinguishing only summer brood trees and winter brood trees. Throughout the range of the pine belt we find that the following classification of seasonal loss can be easily followed by the average cruiser and that for all practical purposes it is good enough.

Trees attacked during May, June, July and up to August 20th, will be abandoned before winter and are classed as summer brood trees.

Trees attacked after August 20th will not be abandoned before winter and are classed as overwintering brood trees.

REFERENCE REPORTS:

1919 - Hopkins, Bioclimatic Law - Scientific Monthly, June 1919.
Relation of Insect Infestation to Phenological Events. Keen - 1916.
Miller - Relation of elevations to the brood periods and generations of D. brevicomis - 1917.
Miller - Studies of Infestation, Sequoia National Park.
Evenden - Seasonal History Studies, Northern Idaho.

MR BURKE: I would like to ask Mr. Miller if he has data from the higher elevations?

MR MILLER: No, only those two experiments that I have mentioned. We have no brood recores from trees that have been attacked by beetles for any elevations higher than 6000 feet and if we carried it higher than that I don't know what the result would be. Mr. Rust has put in all the time he could this season on the study of the D. brevicomis and the D. monticolae and he finds that there are two complete broods of D. brevicomis at Coeur d'Alene at a mean elevation of 2300 or 2400 feet. First activity starts about May 1st and the activities continue until about Nov. 1st. Activity starts about forty days later than at Ashland but they were able to get through two generations before the end of the season.

MR BURKE: "This species was found only in the large yellow pine. Old adults were quite active under the bark of infested trees during April and May. From April 5th to June 1st, practically all of the brood was in the larval stage. From June 1st, to June 10th many larvae transformed to pupae and there were a few young beetles. After that date the beetles began to get common and emergence holes were found. All of the observations indicated that in the locality of the control work there is only one brood a year. The period of principal emergence is from June 15th onward. Lightning struck trees and those dying from mountain beetle attack are the main breeding places."

I think that was at about 4500 feet elevation.

I was interested to see if there was any locality where there was just one brood.

MR KEEN: At Klamath Falls an elevation of 5000 feet the general emergence for 1922 was from June 1st to June 15th and at the same elevation at Bly, the general emergence was from June 15th to July 1st, practically two weeks later. The difference was probably due to a south exposure in the first instance and in the second instance to a north exposure. But at Klamath Falls at the elevation of 5000 feet, we recognize two broods a year, the summer and winter broods.

THE CHAIRMAN: I am convinced Mr. Rust's dates are correct.

MR BURKE: That would agree with ours. I mean, of course, we didn't do enough to tell whether there were two generations; but according to this diagram you have here our beetles could have hatched about the same time as your summer generation. They came out probably a little later. There may be two generations up there but we don't know.

THE CHAIRMAN: What surprises me about this data which we have here is its comparison with the chart of Mr. Patterson which shows two generations, and extended over a much longer time.

I believe Dr. Hopkins made the statement that there were one and one-half generations but not two complete generations.

MR BURKE: I would like to ask about this point: are there ever two complete generations of any insect. I don't know of a single insect where there is even one complete generation, certainly not among the insects that I have studied carefully. I was just thinking about what Mr. Miller said was the case at that elevation in Ashland.

MR MILLER: I think we can qualify that a little in the case of summer brood trees. Trees that are attacked in the early part of June in the Sierras are thoroughly abandoned by the first of September, not only by the brevicomis beetles, but the predators as well.

MR BURKE: You think you couldn't find any others?

MR MILLER: We haven't made a close enough examination of all the bark of the summer trees to say definitely that there are no stragglers left by winter; there may be a few here and there that might hold over to the next spring.

MR KEEN: What I had reference to at the Ashland station, we found that the summer brood was only about 40% of the total broods of the year; the overwintering brood about 60% of such. In other words, we don't have two complete generations; apparently they didn't all go through a summer generation but there were enough struggled through to make one generation.

MR MILLER: In that case I recall only one or two seasons that you have any definite record from. I was fully convinced of that point myself about that time, but we have since found that the ratio of summer to winter-brood trees varies according to the season. In the case of the California epidemic I have an idea that at least 75% of the seasonal loss would be in the summer brood. It seems to be just a question of the condition of the epidemic at the time. If it is an increasing epidemic there will be a big summer generation.

MR BURKE: Just because we find that brevicomis, so far as our study goes, only goes through two generations, I don't believe we want to draw a conclusion that this would always hold good. Now, the Southern Pine Beetle is a close relative and goes through five or six certainly more than one or two, and the farther south we do you will find that we get more than the two generations, but I think that we souldn't hold that any insect will do a certain thing under all conditions.

MR KEEN: I think it would be valuable to have a statement from the different ones located in the different parts of the country as to the first activity in the spring and the latest activity in the fall. That is, the general activity of D. brevicomis, and approximately how many generations a year, in order that we may get a general range of conditions all the way through

from each of the various territories as to when they expect the first activity and when that activity ceases, starting at the south end and going as far north as we have records.

MR. PERSON: I have some interesting data from bark collected at Klamath Falls, which I will read.

Table Showing Partial Rate of Development
and emergence of D. brevicomis at
room temperature 74° F.

Bark collected on Klamath Falls Project Dec. 9, 1922, but kept out doors at low temperature until Dec. 23, when the bark was put inside at room temperature. Bark contained large larvae when brought inside. Bark examined Jan. 10, 1923 contained new adults with some pupae. Bark placed in wooden cage. Emergence from cage into glass vials.

Jan.	11	-	2	new	adults
"	12	-	4	"	"
"	13	-	2	"	"
"	15	-	40	"	"
"	16	-	34	"	"
"	17	-	42	"	"
"	18	-	43	"	"
"	19	-	54	"	"
"	20	-	29	"	"
"	23	-	21	"	"
"	25	-	1	"	"
"	26	-	6	"	"
"	27	-	4	"	"
"	29	-	1	"	"
"	30	-	0	"	"
"	31	-	0	"	"

Females predominated until past the middle of emergence while males were most abundant during the last ten days.

MR BURKE: As Mr. Miller said in his paper, it is the temperature that is the critical factor. But moisture also has a great deal to do with the development of insects.

MR PERSON: In the instance I spoke of the bark was dry, the room being steam heated.

MR BURKE: It would be interesting to know about the development where the moisture is an element, but maybe that will come up later.

BARK COUNTS AND WHAT THEY INDICATE.
by
J. M. Miller.

The object of bark counts in the case of the western pine beetle is to arrive at some quantitative data regarding the degree of attack upon living trees, the subsequent progeny developing from these attacking beetles the amount and causes of mortality during the brood period, and the final effective emergence of new beetles. The points to be determined in the counting of a square foot of infested bark are the following:

1. No. entrance holes
2. No. parent adults attacking -(based on actual counts or averages (per attack.
3. No. ventilation holes.
4. Length of egg-galleries
5. No. eggs.
6. No. larvae pupae, and new adults

In the case of bark from abandoned trees the counts are limited to:

1. No. entrance holes
2. No. ventilation holes.
3. Length of egg-galleries
4. No. of exit holes.

The direct application of this data is to show the effective projeny which eventually develops from the parent beetles which attack the trees. From the time that the eggs are deposited until the new adults emerge from the bark there is a varying mortality throughout the entire brood period. From the averages determined from various counts this brood mortality has been found to approximate 77%. This mortality, the causes of which have not been fully determined, still allowed a potential increase of 415%.

From the time that the new adult beetles emerge from the brood trees until they successfully attack new trees, another period of mortality occurs which may be termed the flight mortality. This may be approximated by determining from averages the number of beetles emerging from trees on a definite and comparing with this the number of beetles which subsequently attack new trees on the same area. In the case of one unit on the Rogue River area this mortality was found to be 90.7%.

The immediate objective in continuing this bark analysis work will be to build up our stock of quantitative data on Dendroctonus beetles and to determine if possible the causes of effective mortality. Eventually we may be able to recognize these causes and to predict their probable effect upon the increase or decrease of infestation.

The mechanical phase of bark analysis work is one of its most discouraging features. In the case of the western pine beetle it is necessary to cut into fine pièces every cubic inch of infested bark in order to find all of the brood. Various methods have been tried such as the knife and the plane but they are all extremely slow. At the best a man can not cut up and count carefully more than two or three square feet of bark in a day. During the winter of 1923 a bark slicing apparatus was developed at the Northfork station which just about doubles the speed of this work.

Reference Reports:

Bark Statistics - Life History and Habits of D. brevicomis
F. P. Keen, - Ashland, Ore. 1916.

Count of broods in infested tree on the Antelope Project Area.
J. D. Roggs - 1914.

Bark examination - Rogue River Area.
W. E. Glendenniny - May 1916.

Bark Statistics - Third Report - Greenspring Slash Study.
J. E. Patterson - 1923.

Statistics from Bark Counts:

Galleries constructed at rate of .65 in per da.
Straggling emergence may last 99 days.
Flight lasts approximately 26 days.

Attack per square foot	6.8
Parent Adults per sq. ft.	17.6
Ratio, females to males	54.46
Inches of gallerys per sq. ft.	187.8
Eggs per sq. ft.	636.
Ventilation per sq. ft.	17.7
Emergence per sq. ft. (adults)	80.
Parent Adults per attack	2.59
Eggs per female	64.6
Eggs per inch of gallery	3.39
Eggs laid per day	2.2
Average length of gallery	10.74
Average no. P.A. per gallery	2.2
Average no. entrance holes, sq. ft.	10.6
Average no. ventilation holes, sq. ft.	27.
Average no. exit holes per sq. ft.	182.5
Average no. larvae per sq. ft.	221.5
Average no. n.a. emerged per sq. ft.	168.5
Ratio of larvae to new adults	4.3
Ratio of exit holes to new adults	11.10

Analysis of attack and Loss on Lamb's Mine Unit for the two years 1918 and 1919. Also increase in D. brevicomis adults and mortality during some stages of development.

Loss:

1918 loss - 81 trees; 63,550 B.F. 22,182 sq. ft. bark surface

1919 " -32 " 20,780 " 8,651 " " " "

Statistics:

1918: No. beetles attacking per sq. ft. of bark 15 P.A.

Attack, 81 trees	332,182 "
Attack per tree	4,108 "
Attack per M.B.M.	5,270 "
Attack per sq. ft. bark surface	6.3

Eggs per tree	74,520	
Eggs, 81 trees	6,036,120	
Eggs per M.B.M.	98,000	
Eggs per sq. ft. bark surface	272	
Emergence per tree	17,250	N.A.
Emergence, 81 trees	1,397,750	"
Emergence per M.B.M.	22,000	"
Emergence per sq. ft. bark	63	"
Brood Mortality	77%	
Increase per cent	415	

1919: No. Beetles attacking per sq. ft. of bark ------ 15 P.A.

Attack, 32 trees	129,765	P.A.
Attack per tree	4,055	"
Attack per M.B.M.	6,450	"
Attacks per sq. ft. bark	6.38	
Eggs per tree	74,520	
Eggs, 32 trees	2,384,640	
Eggs per M.B.M.	115,000	
Eggs per sq. ft. bark	275.65	
Flight Mortality	90.7%	

TABLE II.

SUMMARY OF BARK COUNTS

Locality	Year	Status of infestation.	No. attacks	No. P.A.	No. eggs	No. larvae	No. pupae	No. adults	No. emerging	No. predators	% Brood mortality.	Basis for Figures: No. sq.ft. counted	Recorder
Ashland	1916	Epidemic		17	216				80				Keen
"	1918	"	6.3		272				63		77%		
"	1919	"	6.38		275								Glendinning
"		Declining		15		185	122		50	85			

THE SECRETARY: In regard to the counts, how did you come to your conclusions as to those numbers?

MR MILLER: It is based on the average per square foot of bark. We have the records of actual counts from about 720 square feet of bark on which we based these averages and then from the bark surface table which were worked out by Mr. Keen, the totals for the trees were completed.

MR KEEN: I would like to ask which of the various data that have been secured so far give the best indications as to whether the infestation is increasing or decreasing?

MR MILLER: So far we have found a varying brood mortality and flight mortality connected with certain infestations, but so far we are unable to say what they indicate.

MR KEEN: Can you conclude that you have a certain brood mortality in these counts and another brood mortality in this count, that this same infestation is increasing and the other declining?

MR MILLER: We cannot definitely predict what is going to happen. The study has not been carried far enough to be safely applied in this way.

MR BURKE: I would like to ask Mr. Patterson as to this flight period, as to the time they strike the trees; it looks like a great many adults in striking or attacking the trees, would be lost. Is that included in the flight mortality?

MR PATTERSON: A great many adults evidently are lost during flight, this mortality was not included in that given for the Bark Counts, it is separate. Since the work that has just been reviewed was done, I have carried out a small amount of work of the same character in the Rogue River area. At the present time the infestation in the Rogue River area is down. It is lower than it was in 1914 at the beginning of the study, and we found that while the records are not extensive, or anything like that, since it is not possible to find many infested trees now; we found in those that we did examine and worked up that the infestation per square foot of bark was well below anything that we had found before which indicated or appeared to indicate that in a very low infestation an endemic condition that the number of individuals per square foot of bark are greatly lower than during the epidemic stage; possibly we may get more data that will give us more light on this. Our information is very meagre and we haven't much to go on.

MR PERSON: Could there be any correlation between the number attacking a tree and the number of different stages of the brood development. You would naturally think that in an epidemic infestation that the number of beetles attacking a tree would be greater than in an endemic infestation, and the length of the egg channel and the number of eggs and the number of larvae developing would be smaller where the number of beetles attack the tree would be smaller. Could anything be worked out along that line?

MR MILLER: There is very little variation in the number of beetles attacking per square foot of bark. That is the one fairly constant factor we have found. It seems that the attack has to be just about so strong in order to overcome the resistance of the tree, otherwise the beetles are overcome by the sap flow. Our counts, so far, do not show much variation in the attack either for an increasing or decreasing infestation.

BRANCH OF RESEARCH

June, 1927

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NATURAL CONTROL

(By W. D. Edmonston)

Under normal conditions of a forest we assume that the combined influence of these factors is to a greater or less extent responsible for maintaining that balance which governs the survival of the fit in the keen competition always present under the natural law of plant and animal life.

Under abnormal conditions, such as those found in a forest which has been subjected to a heavy death rate through insect infestation, continued over a long period of years, we again assume that it is due to the failure of these same factors, one or more or all, to maintain that equitable balance which we again assume must be present in the ideal forest, according to our mental vision of such.

There is no ideal forest under natural conditions. Death in many forms stalks the forest.

Coniferous forests exist today and have for ages, climatic conditions so far as we know have not changed during the life time of the forests as we know them today. We have all seen pine trees that we know must be four or five or more centuries old. As a matter of fact we know of millions of trees in our western forest that have reached the age of 250 years. During that time they have withstood any and all changes of climate, sub-normal or abnormal, or they would not compose our present day forests.

Heat and cold then, if abnormal at times, have not resulted in the death or extermination of any tree species that we know of. Neither has it done so with the insects that infest and kill these trees, or any or all of the factors combined either enemies or friends.

Nature produces everything in lavish abundance. Why? It is much the easiest way. The weak succomb, the strong survive, but not all the weak or all the strong, under this law many of the strong are sacrificed, but what of it? Others take their place.

What we term an epidemic infestation by a species of barkbeetle may in the natural course of events be perfectly normal when viewed from the point of natural law. We, however, wish to check these spurts of nature bent on destroying what we wish to conserve for present or future use.

Now, what help can we expect to get from natural factors, such as disease, parasites, predators, and birds? Very little until we understand them better, in any case under an epidemic ~~fram~~ form of infestation we are compelled to take drastic measures and perform a major operation.

In the Pike National Forest, Colorado, in the canyons west of Colorado Springs, southern exposure, altitude 8000 feet, the pine and Douglas fir were subject to a sudden severe change in temperature, from heat to cold. Exceptionally mild weather through January and part of February, 1916, was followed by freezing temperature well into March. The result of this was to discolor and dry out or kill the leaves. The leaves of the Douglas fir assumed a redish brown tinge, the pine a yellowish brown. By August 15th it was hardly noticeable, no pine died, a few Douglas fir saplings which we had under observation, died, with no evidence of insects present; subsequent observations up to 1922 show no increase in the tree killing power of D. ponderosae or the Douglas fir beetles. There is only slight endemic infestion in this region. In the Wet Mountains Division of the San Isabel Nat. Forest, West of Pueblo, Colorado, similar conditions prevailed that same spring, and there is some quite heavy infestation in pine ten miles south of the areas worked in 1909, mostly on private holdings. When this area was examined in the fall of 1915, there was no change in the six year period. It was examined again in the fall of 1922, a seven year period, and there was no noticeable change. The infestation is still quite heavy but not more so. It would appear from this that there was no increase or decrease following a very severe and abnormal climatic change, which made the pines and firs look as if they had been struck by a blight and later heavy defoliation.

I am now assuming that the trees and the insects have become inured to both heat and cold, as it is part of their vary existence and does govern the limits of distribution of the various species.

Dendroctonus ponderosae has few if any parasites. I do not know of any. D. convexifrons has one. I secured it in 1915. It was in the pupal cell in the outer bark, two larvae were secured. They were not in cocoons, Mr. Rohwer identified them as Hymenoptera probably Chalcids.

Mr. A. B. Champlain while connected with the Station in Colorado, undertook the study of parasites and predators of Dendroctonus. He found no parasites on D. ponderosae, but a number on D. pseudotsugae. One a Braconid, very common, parasites of secondary barkbeetles in Pinus were common.

Predatory insects are generally common. Enoclerus sphegeus and Trogosita virescens may be quite beneficial in destroying the broods of D.ponderosae.

The influence of predators is more noticeable in an endemic than in an epidemic infestation. You will always find on an epidemic area that the predators are more numerous where the infestation has been concentrated for two or more seasons and where only the retarded broods remain to infest a limited number of trees, the main broods or strong healthy colonies having migrated, perhaps not very far, but at least far enough to escape from disease and their enemies.

In my opinion, that is why we find, after a lapse of time, five or eight years or more, that the trees that were passed in the first few seasons of concentrated infestation, are now being heavily infested.

Woodpeckers are very beneficial but more so under normal conditions. When there is an abundant food supply during an epidemic they are more inclined to work on the abandoned trees, redtop trees, the reason being that they get as much or more food and with less work. When they do work on trees containing broods of the primary barkbeetles they select those with thin bark. We must also take into account that it is unlikely that they have any preference, which means that they are just as likely to destroy the friend as the enemy.

Five species of wood peckers which I secured in two days time, in the vicinity of an insect deadening and scattering infested trees, were sent into Washington for examination. The report showed that their food supply had consisted chiefly of ants.

Fungus or bacterial diseases are more noticeable after, than during the time when most of the destruction is taking place. I have already pointed out that by moving or migrating D. ponderosae is able to continue its destructive work before it is finally hemmed in to be finally overcome or reduced to a low ebb, most likely by a combination of these very factors which its work has produced.

MR BURKE: There is one instance where the temperature did stop an epidemic, according to Dr. Hopkins, probably all of you have read about it. You remember the big epidemic along in '91 or '92 of the Southern Pine Beetle in Pennsylvania or West Virginia. That is one instance where the temperature had something to do with the situation.

Talking about birds — I guess Mr. Edmonston remembers the time up at Highland. The little birds, creepers, followed us around? I don't know whether they would work in the summer time and catch the beetles; they probably are not strong enough to dig them out of the bark. While we were examining the trees they would follow us around and then go in and eat the beetles. The way they acted indicated they were in the habit of eating them.

THE CHAIRMAN: Yes, I think we should know more about our beneficial birds. An examination could be well made as to what percent of their food, at certain times of the year, consists of forest pests.

MR JAENICKE: I feel that the further study of the factors which bring about natural control will eventually lead to explanations for the sudden increases or decreases in our epidemic infestations. Such data may make possible short-range predictions of the trend of endemic and epidemic infestations.

MR MILLER: I think Mr. Edmonston hit the nail on the head when he said we don't know what the influence of natural control may be until we know more about the factors. The reason that we don't know more is due to the fact that we assume certain things are true and never carry out any real experiments to test them out and to find out whether they are only assumptions or whether they are real facts.

Mr. Keen brought up a point regarding the killing of western pine beetle broods. I have seen the same thing happen, and it was possibly not due to cold, but due to solar heat. The problem of those dead broods which we sometimes found in the bark puzzled us for a number of years. We assumed that some of it at least must be due to frost killing. After it had been demonstrated that solar heat will effectively kill the broods on the top of down logs exposed to the sun, much of this killing could be satisfactorily explained. However, we do not yet know the degree of cold that is required to kill the broods.

THE SECRETARY: In regard to this matter, Mr. Keen spoke about them freezing and Mr. Miller spoke about the sun doing the work. I would like to split the difference and say it was both, probably the freezing and the sun alternating.

MR KEEN: The occassion I had in mind occurred in February therefore must have been due to cold.

MR MILLER: The point I am trying to bring out is that it is experimental either way. It might be heat or cold that was the factor.

MR EVENDEN: Our famous Red Belt in Montana is caused by the sun coming out in the spring while the tree is still frozen.

FLIGHT HABITS OF D. BREVICOMIS.

(By F. P. Keen)

There are two ways to approach the problem of flight habits of bark beetles. (1) By obtaining direct evidence such as through the liberation and subsequent capture of marked beetles and (2) by making general field experiments and observations as to determine the shift in the intensity of infestation where the equilibrim of nature has been upset.

Under the first classification I wish to mention the flight experiments carried on by the writer at Ashland during 1916. Large quantities of D. brevicomis were successfully reared. A method of marking with an analine dye was worked out and a method of detecting the color. Successful results were very few, however, and the experiment was practically abandoned at the time of the war. (Reference to Report of F.P.Keen on Flight Habits of D. brevicomis, Ashland, Oregon, 1916).

Another means of securing direct evidence is in the finding of infested trees far from any source of infestation. Direct evidence was secured by the writer that they do fly at least 500 yards and attack standing trees. Mr. Patterson has recently conducted an experiment at Ashland which shows conclusively that the beetles flew at least 1-1/4 miles and attacked a trap tree in great numbers.

Indirect evidenses:

Indirect evidence is abundant all of which that has come to the attention of the writer would seem to support the theory that under normal forest conditions the beetles do not fly far to attack standing healthy trees; and hence what has been called the sphere of influence is rather limited.

In the fall spotting work of this year on the Southern Oregon-Northern California Project where most of the trees were green, practically all of the newly infested trees were found by closely inspecting the trees surrounding the trees of the previous generation. The spotters naturally dropped into the habit of locating the new trees in this manner. The consistence with which this relationship held out shows that there must be some connection between the trees of the two generations.

On the seasonal history studies at Ashland, Oregon a great many groups were studied, where the infestation in new trees could be followed back through two years of old loss without going out of a 200 yard circle; and the rise and decline within these circles was in the same ration as the rise or decline throughout the area.

The influence of control work on the Southern Oregon-Northern California project Horsefly Unit is a good example of the localized character of the effect of control work.

During the spring work only the north half of the Horsefly Unit was covered with control work. During the winter the south half was worked, using the sun curing method. In the fall this south half was reworked and the work extended up and over a part of the spring treated area. Two things were very noticeable, first that the summer work hadn't made the slightest impression on the following overwintering generation, and secondly, that as soon as the spring treated area was reached the infestation was so slight that it did not pay to run the camp any longer and it was closed down. The attached map shows how the overwintering generation of 1922 fell off right along the line of the Spring treated area.

Commenting upon this situation, Dr. Hopkins in a letter dated Nov. 23, 1922 writes:

"There is no doubt that all of the Dendroctonus beetles can and do fly for long distances from the trees in which they have bred and that they are attracted to certain trees and centers from all directions. There is, therefore, no way of securing facts or evidence to prove where the beetles come from that attack a tree near one from which the broods of a preceding generation have emerged.

The only explanation of the case you mention that I can think of is that the larger number of infested trees left in the untreated area contributed to a greater intensity of the attractive influence than in the treated area and thus resulted in more trees being attacked. It is evident that one of the principal attractions for the beetles is a freshly attacked or infested tree, the intensity of the attraction increasing with the number of infested trees in a given locality and that the number of trees attacked depends upon the number of flying beetles within the limits of the distance to which the influence extends.

Evidence in support of this general principle of centers of attraction is found in the discovery by the spotters that the place to look for newly infested trees is in the vicinity of the trees from which the preceding generations have emerged. This feature of the principle does not always hold, however, for a greater intensity of the attractive influence may cause all of the beetles to go to another and sometimes a distant center. This was a striking feature observed by me in the ~~gaaaaaix~~ great epidemic of Dendroctonus frontalis in West Virginia in 1892 and I think referred to in Bulletin 83. Sometimes the new centers would be many miles from the preceding centers adjacent to which no, or but very few, newly infested trees could be found. The same feature of the principle was observed in the Black Hills and in other extensive epidemics that I have studied.

The whole subject of attractive influences and the character of the responses of the different species of *Dendroctonus* beetles to them is one of special interest and economic importance which should be studied in connection with every inspection or control project."

MR KEEN: I would like to hear from some of the older men in this work as to the beetles coming from a long distance. From what I have seen and most of the control work shows that the influence of the control work has only to a limited extent affected the surrounding area.

MR BURKE: Well, I believe, of course as Dr. Hopkins says, the trouble is that we fit a few cases that we have seen into the theory. Now, both things may happen. In the life of every individual animal there is certain times when it seems to be natural that there should be a location close by, then there are other times when the migratory instincts take effect. There can be no doubt but but that there are certain times that the insects do jump for long distances. I have never seen one of those great flights of insects. I think Mr. Keen is probably right on this project. But we can't judge conditions that we find on one project as to what will happen on another.

MR EDMONSTON: I have never dound in my observantions that they move. The only record I have is for only a distance of seven or eight miles and then, I think, for the reason that there was some infestation in that area. They seemed to move backwards and forwards. Trees were killed for two or three years in one area and then the beetles would move and then come back into the area and go to work again. That is the D. ponderosae, of course. After the second year of control work there seems to be a reduction. In moving, they fly from twelve to fifteen feet above the ground. We tried an experiment with a screen about fifty feet long and I don't know how wide. The D. ponderosae would come along and go over the top of the screen; I saw that. As to movements over eight miles, I don't know of any. Seven miles, I would say.

MR BURKE: I think Mr. Edmonston is about right; if they get in a strong breeze they will coast pretty well.

MR EDMONSTON: They fly against the wind.

MR BURKE: They do? Maybe I don't know what I am talking about. Some insects will fly against a gentle wind and with a strong one or vice versa. This point should be studies with Dendroctonus.

MR KEEN: The little experience that I have had verifies Mr. Edmonston's statement. We hand tangle foot screens put up at Ashland and we didn't catch a great many of the beetles; the records that we did get indicated that they flew against the wind.

MR EDMONSTON: They fly about this angle — 20 degrees.

MR MILLER: I have never been able to see them; that is my greatest difficulty — for more than a few feet after they left the point of emergence. There are two or three records which we might call absolute records where we know the beetles have come a certain distance to reach certain points, but possibly that will come out under the next paper.

Mr. Patterson has some evidence from the Antelope Project which rather contradicts what Mr. Keen has from the Southern Oregon Project. That, I think, ought to go in the record for fear we may become too enthusiastic over the local influence of control work. Could you give that to us, Mr. Patterson?

MR PATTERSON: On the Antelope Project the first work was conducted on the west half of the Project; this project is about 80,000 acres, in area and we controlled about 40% of the project the first year. That control work was all confined to the western half. In making a survey of the project after this control work had been done, after the first subsequent infestation had settled in the trees, we found that on the area that we had controlled that the recurring infestation amounted to about 19 trees per section; while on the eastern half the infestation averaged 20 trees per section, which was a reduction over the previous year and it indicated that the control work had rather balanced the infestation all over the area. The eastern portion, some of it, was eight or nine miles distant from the center of the western half. That seems to contradict Mr. Keen's findings on the Klamath Falls Project.

I don't know what connection there would be between the two projects.

THE CHAIRMAN: That point is well taken; we can't place too much dependence on one project.

MR KEEN: What evidence was there that the infestation would not have declined this percent if no work had been done?

MR BURKE: We have nothing to prove or disprove that.

MR EDMONSTON: One thing, I have noticed that the ponderosae follow the contour of the country; they follow the main infestation around; they don't cross over the divides.

MR KEEN: I would like to mention something here about following contours and I don't believe it has ever been brought out in this connection before, and that is that there is an infestation belt which follows certain contour limits. On the Southern Oregon Project the upper level of this belt is about at 5500 feet; any time you reach 5500 feet whether it is a south or north exposure, you practically get out of infestation and when you get into the mixed pine and fir on the ridge it starts to peter out. But below that

5500 it starts in again.

MR MILLER: That 5500 feet contour holds good in the Sierras also. Below that contour the pine is subject to heavy infestation, but above that there is a decided dropping off of infestation. However we do find the Western Pine beetle extends up to the 6000 foot contour.

MR BURKE: You don't think that is because of the mixed type of timber up above 5500 feet.

MR KEEN: I have no explanation for it.

THE CHAIRMAN: We seemed to have wandered from the subject under discussion. I do know that Bark Beetles do swarm; whether that is confined to the secondary type, I do not know.

MR EDMONSTON: I have never seen what you determine as a flight; I have seen individuals passing; I am pretty sure that is right because I have caught some of them in a net. I have seen flights in mill yards and they go all over the place.

MR MILLER: All theixx records that we have of attacks contradict thr idea that there is any swarming or general flight of the Dendroctonus beetles. We have a number of flight records in the case of the Western Pine Beetle. Mr. Patterson has the records of the attack of the D. monticolae in lodgepole pine and in both cases the attack is strung out over quite a period of time, a week or ten days, or even longer. And the beetles that come into the trees come singly, a few at a time. But under abnormal circumstances there might be a flight, a swarm of beetles.

MR JAENICKE: Data on the flight habits of various species of Dendroctonus will go far to settle for us what a safe and adequate insect control unit is. Ordinarily, Dendroctonus epidemics are found to exist over large contiguous areas. If, because the flight of the beetles is found to be limited it is possible to divide a large infested area into a number of divisions which are entomologically independent of each other, it would be feasible to so arrange the sequence and rapidity of the control work to meet the financial and personnel limitations placed on the control work. If, on the other hand, the beetles fly long distances and in great numbers, no control program would be effective which did not take the entire infested area in consideration. As I see it, the settlement of the flight habits of Dendroctonus beetles will have a far-reaching influence on control plans.

ATTRACTION OF DENDROCTONUS BREVICOMIS TO HOST

by - J. E. Patterson.

Summary of Experiments and Observations on Caged trees, Trap Trees and Group Infestations.

The following summarized notes were taken in connection with experiments and observations relating to the above named subjects, conducted in southern Oregon and northern California.

The notes on these subjects are given under the separate heads:

Caged Trap Trees:

The following technique was employed in conducting experiments on the attraction of Dendroctonus brevicomis to caged yellow pine trees.

Healthy standing trees were selected for the host: A cage approximately 7 feet square and 8 feet high was built around the base of the tree selected. This cage was covered with heavy white muslin cloth attached to the framework of the cage so that it was impossible for insects within the cage to get out or for insects outside the cage to get in. Yellow pine bark infested with broods of D. brevicomis was then removed from infested standing trees and placed in the care around the base of the tree. The adult beetles after emerging from the caged bark were unable to escape from the cage and were then forced to either attack the portion of the tree within the cage or to die without making an attack.

The object of the experiments was to force an attack on the caged portion of the trees which would result, it was believed, in setting up conditions within the tree which would attract beetles from the forest to attack the tree above the cage.

It was expected that these experiments would result in securing data on the attraction of D. brevicomis to host and the distance attractive influence extends from the host tree.

A summary of these experiments is given as follows:

Experiment 1 - Ashland, Oregon. May 12, 1919.

A yellow pine tree 22 inches in diameter was selected in the forest sough of Ashland. This tree was caged in the manner described above and infested bark was placed in the cage May 12. The bark contained a brood of pupae and new adults.

May 23 - A number of beetles had emerged in the cage but none had attacked tree

June 5 - A number of attacks had been made on the caged portion of the tree.

June 9 - Attacks by beetles outside the cage had been made on the tree above cage.

June 25 - The entire trunk of the tree above cage had been attacked by beetles from the field. The brood at this time consisted of parent adults, eggs and young larvae.

Results: These show that the attacks within the cage had resulted in attracting beetles from the surrounding forest to the caged tree within 4 days after attacks had been made on the caged trunk. They also show that first attacks on a tree have an attraction for other beetles flying within the adjacent forest but owing to the fact that the location of the nearest infestation to the caged tree was not known. No data on the distance the attraction extended from the caged tree were secured.

Experiment 2 - Jenny Creek, Oregon. May 27, 1920.

A healthy yellow pine tree 36 ins. in diameter was selected for the host. It was caged by the method already given and infested bark containing pupae and new adults of D. brevicomis was placed within the cage. Before the tree was caged an intensive cruise was made of the area around the tree and all infestation within a radius of ½ mile was thoroughly cleaned up by burning all broods of D. brevicomis in this zone.

May 27 - Infested bark placed in cage.

June 10- A number of new adults had emerged but none had attacked the tree.

June 20- Heavy emergence of new adults from the caged bark; a few attacks were noted on the caged portion of the tree.

June 25- First attacks on part of tree above the cage.

July 1 - Tree above cage completely attacked. This brood consisted of parent adults, eggs and young larvae.

Results: This shows a repetition of events which occurred in the first experiment. That the form of attraction, whatever it is, is effective in drawing flying beetles from the adjacent forest to the caged tree. In this experiment it is known that the beetles in the field were either attracted a distance of at least ½ mile or that numbers of them were flying about within the cleared zone surrounding the caged tree at the time the attractive influence existed.
It was also noted in this experiment that Clerid predators and one species of Dipterous parasite arrived at the caged tree before any individuals of brevicomis did. In other words they were on hand to attack the beetles as soon as the latter arrived at the tree.

Experiment 3 - Jenny Creek, Oregon. June 10 to Sept. 30, 1922.

A healthy yellow pine tree 24 ins. in diameter was selected in an area of approximately 1 mile in diameter where there was no infestation of D. brevicomis in either standing trees or slash. This tree was caged as in the preceding experiments and infested bark placed in the cage on June 15th.

June 20 - Beetles were emerging from the caged bark and were attacking the caged trunk of the host.

July 10 - Emergence from the caged bark was over and all attacks on the portion of the host within the cage had failed. Not a single attack had occurred above the cage although a number of Clerid predators were captured on the trunk above the cage during the period June 20 to 25th.

July 30 - The abandoned bark within the cage was removed and fresh infested bark was put in.

Aug. 10 to 20 - During this period adults emerged from the caged bark and attacked the tree within the cage. Adults Clerids were captured on the tree above the cage as before.

Sept. 30 - An examination of the tree showed that the attacks within the cage had again all failed and that no attacks had occurred above the cage.

Results: The experiment failed in so far as attracting beetles to attack the uncaged portion of the tree. This result may have been due to the probability that the attractive influence in the caged tree did not extend far enough to affect beetles at the location of the nearest infestation, which was 1 mile or more distant from the tree. However, there may have been unknown factor of which prevented attacks by beetles from the field. The experiment shows that a few attacks near the base of a healthy tree are not sufficient to overcome the tree's natural resistance and to kill it. It also shows that some attraction existed because Clerids were drawn from the field.

Felled Trap Trees:

Felled trap trees have been used in southern Oregon for purely experimental purposes and also as an auxilary method of control on the Antelope Project in northern California. A summary of experiments and observations on felled trap trees is given as follows:

Experiment 1 - A series of yellow pine trap trees were felled at different periods during the season of 1920 in the Jenny Creek Area. The first set was felled May 28, another set on July 12 and 20th, and a third set on August 13th.

The area selected for these tests was in a pine stand on a south slope at an elevation of 3800 feet. A high normal infestation of <u>Dendroctonus brevicomis</u> existed on the area and in the surrounding country.

Results: These trees were all attacked within ten days after they were felled. They were all heavily attacked and developed large broods which emerged with a relatively low mortality. The results of the experiment indicate that when trap trees are felled during the summer period in stands where a high normal or epidemic infestations exists they take on heavy broods: and if the trees are attacked

soon after they are felled and before conditions adverse to the development of the broods arise within the trees, that a relatively low mortality occurs during the development stage of the infesting broods.

The trees were watched closely during the first periods of attacks and it was found that Clerid predators and Dipterous parasites invariably arrived before the beetles.

Experiment 2 - The results of this experiment were deducted from the study of the Greenspring Highway road slash in the Jenny Creek Area. A total of 992 yellow pine trees above 12 ins. in diameter and of all ages and physical conditions were felled in a strip 100 feet wide and 22 miles long through a primative yellow pine forest at elevations ranging from 3,400 feet to 4,200 feet. A normal infestation of D. brevicomis existed in this forest at the time the trees were felled; which was from September 1919 to July 1922. The trees were felled and bucked to both sides of the road strip but were not further disturbed.

A total of 976 or 97% of these trap trees were attacked by D. brevicomis. Each tree was carefully examined after emergence and a sample section of bark was taken from each for analysis.

Results: The general results of the experiment shows:

1. That the attraction of trap trees over standing trees is greatly in favor of the traps.
2. That very few trees were heavily attacked.
3. That the condition known as "sour sap" developed in practically every tree.
4. That the brood mortality was excessive, approximately 74%.
5. That there were too many trap trees down during the period of attack relative to the amount of infestation in the adjacent forest.
6. That the last statement probably accounts for the light attack in the trap trees.
7. That the infestation in the adjacent timber following emergence from the trap trees, was not materially increased over that which existed in these areas prior to slash.
8. That slashed material is not always a menace to surrounding primitive timber under certain conditions: i.e. under conditions which existed during this study.
9. That the number of trap trees used as an auxilary method of control can be too many. Where there are too many felled they are not heavily attacked. The right number of course depends upon the amount of infestation on the control area.

Experiment 3 - Felled Trap Trees as an Auxilary Method of Control.

During the progress of control work on the Antelope Project in 1921 and 1922 trap trees were used to localize on accessible areas the first recurrent infestation following intensive control work.

Two series of traps were used in 1921: One of these series was felled in June and one in September.

Only one series was used in 1922 and this one was felled in June.

The number of trees felled in each series was based on an estimate of the amount of the first seasonal infestation following the last intensive work. This number was approximately 12% of the estimated recurring infestation.

Results: All trap trees felled were more or less heavily attacked soon after they were placed. In the trees felled in June the broods developed rapidly and were treated during the latter part of July and in August. These trees peeled easily and were treated with minimum of labor and time. They were no doubt successful in drawing a large amount of infestation away from the standing timber.

The trees felled in September 1921 were not so successful as the broods developed slowly and overwintered in the trees. They were treated with a great deal of difficulty the next spring. A great amount of labor and time was required in treating these trees as the bark held tenaciously to the logs and was so saturated with moisture that it did not burn well.

As a successful form of control the method is somewhat doubtful in efficiency. The trees were fairly heavily attacked and no doubt drew and localized a large amount of infestation. However, there was a tendency to create group infestations in standing trees adjacent to the traps. This was one noticeable effect of the method on this project: a number of instances were noted where these groups amounted to 4 or 5 standing trees per group.

Further experiments are needed along this line before definite conclusions should be drawn.

Experiment 4 - Trap Trees Felled in Isolated Areas.

This was purely an attraction and flight experiment and was carried out to learn if it is possible to draw infestation to a pine stand remotely situated.

It was carried out, under the following conditions, in the Rogue River Valley during the late summer of 1922. A yellow pine tree in a small grove of this species on the summit of a small butte at an elevation of 4,100 feet was felled August 19th. The grove of pines, of which the trap tree was a member is located at a distance of 1 mile from the nearest trees of the same species. There was no infestation of any kind in this grove. The area surrounding the grove on all sides except the east side, is lower in elevation and is barren

except for scattered areas of small oaks and brush cover. The nearest infestation of any species of pine infesting insects was at least two miles distant west. The attached diagram shows the location, etc. of the experiment.

The trap tree was felled on August 19th. The trunk of the tree was covered with limbs and brush to protect it from excessive heat and from prematurely drying.

Results: August 19 - Tree felled
August 27 - Nothing had attacked tree.
Sept. 15 - Dendroctonus brevicomis, Dendroctonus valens, Ips emarginatus and Ips confusus were attacking the log and stump.
Oct. 30 - Tree heavily infested by above species. The broods of D. brevicomis and Ips. sps. consisted of full grown larvae, pupae and new adults. A thorough examination of the tree showed that the following insects had attacked it.

<u>Dendroctonus brevicomis</u>
<u>Dendroctonus valens</u>
<u>Ips emarginatus</u>
<u>Ips confusus</u>
<u>Asemum sp.</u>
<u>Staphylinids</u>
<u>Clerus (nigriventris)</u>

A cutting test of one square foot of bark taken from near the butt of the log gave the following for the brevicomis:

D. brevicomis	larvae	414
" "	pupae	14
" "	new adults	46
	Total	474
Clerus nigriventris larvae		7

These figures show that the D. brevicomis brood in this tree, in point of numbers of individuals, was far greater than the average brood in any infested standing or down tree examined in this locality. The relatively high percentage of predacious larvae should also be noted.

Points: The tree was at least two miles from the nearest infestation of any insects which attacked it.

It was 1,600 feet higher in elevation than this infestation.

The insects which attacked the tree were drawn from a distance of at least two miles.

Evidently a very strong attractive influence existed.

Predacious and secondary insects were also attracted.

The trees was heavily infested by all species which attacked.

Group Infestations:

Very little data so far has been secured on this phase of Dendroctonus brevicomis infestations. Under certain conditions infestations of this species runs to group attacks but the factors which contribute to this habit are not at all understood.

In treating this subject in a philosophical way it may be said that it is an inherent instinct of the species to congregate in masses whenever conditions are favorable to this tendency. This gregaious instinct or habit is possessed by most forms of animated life and leads the individuals to form groups or to congregate in small to large bands or flocks. It is apparent that this habit, if practised by Dendroctonus brevicomis, would lead to a concentration of the beetles natural enemies within the groups of the host which would result in high mortality to the species.

Observations in infested areas in southern Oregon and northern California show that group attacks and infestations are followed, within two to four generations, by a rapid decline in the general infestation and the breaking up of group infestations with a consequent dispersal of the beetles throughout the forest.

Points: Group infestations are likely to appear as a result of beetles breeding in slashed material or in areas where trees have been injured by fire. This result has been a noticeable feature in slash studies and in studies of the interrelation of fires and insects.

Group infestations occur also in primitive forests where natural conditions have not been disturbed.

It is characteristic of D. brevicomis infestations that one or more generations of the beetles should run to group infestations sometime during the infestation cycle. It has been noted that this condition occurs just prior to the decline curve in the cycle.

Our present knowledge of this subject is vary meager. Further studies and observations on this head are essential before any definite conclusions can be drawn.

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Respectfully submitted,

(Signed) J. E. Patterson.

Ashland, Ore.
January 29, 1923.

MR MILLER: On the Sequoia National Park in 1918, a record of flight was obtained under conditions similar to those of Mr. Patterson's experiment. On the Sequoia the distance of flight was one and two tenths miles (1.2). That is the distance from the trap tree to the nearest infested tree that we were able to locate. The ~~xkm~~ thing that struck me about Mr. Patterson's experiment was that the beetles apparently in coming from the nearest infested tree, make a rise in elevation as they come from a lower altitude into a higher one to cover that distance of two miles or more. We tried at Northfork to induce the beetles from the higher elevations to the lower with no results whatever. Trap trees were cut down below the general pine belt in localities that were quite isolated from the pine beetle infestation: the distance of the trap trees to the nearest trees infested by D. brevicomis was something like two or three miles. The elevation of these trap trees was about 2000 feet while the nearest infested trees were about 1000 feet higher. The Flatheaded borers were attracted to the traps and also D. valens which attacks digger pine, a host generally distributed through the foothill belt. But neither D. brevicomis nor Ips reached the traps.

As we failed in this experiment, we tried the next year to plant infestation down in that low territory. Possibly there was something about the growth of the trees under those conditions that had something to do with their failure to attract the beetles.

During March and April about 500 square feet of infested bark was carried down and placed in a small isolated grove of about 25 yellow pine trees. A subsequent count of the exit holes shows that there was a total emergence of about 22,583 beetles, that undoubtedly took flight right in that one center. There was an attack made on the base of the tree against which the bark had been piled. We counted 492 attacks which had been made by some of those 22,000 beetles upon the nearest tree. All attacks had failed because of the sap flow, or sap resistance of the tree. During the summer we tried it again; we took another load of bark down there, but the emergence from the bark planted in the summertime was much lighter than that from the spring bark and the total emergence was correspondingly much less. We found about 30 attacks, however, that seemed to come from the emergence of these summer brood beetles.

Summary of Important Points
in the Seasonal History of D. monticolae

Seasonal History with variations under Bioclimatic Law (See Table) similar to D. brevicomis table.

Life History

Female makes the attack and is followed by the male.
Copulation occurs on surface of bark before attack is made
Attack has been observed to last 28 days with a minimum of 5 days.
Parent adults noted emerging 36 days after attack.
First egg found 14 days after attack.
First larvae found 28 days after attack.
Females construct egg galleries at rate of $\frac{1}{2}$ inch per day.
Activities during attack continue overnight.
Attacks per sq. ft. 4.
New adults emerging per sq. ft. 60.
Mortality between eggs and N.A. emerging 81%
Percent of increase 90%.
Brood period attack to emerging 129 days.
Beetles often attack and kill only a strip on one side of lodgepole pine.

Natural control

Two parasites, one predator found. Woodpeckers very effective at times.

Artificial Control

Control may be effected through utilization in milling operations if the bark is destroyed or the beetles submerged in the mill pond for a considerable period of time.

Control may also be secured by peeling and exposing the bark of by burning the bark.

In sugar and yellow pine the bark should be entirely removed and exposed or completely burned on the log. Scorching is not effective.

In lodgepole and white pine the trees may be felled and the bark scorched or in some cases peeled from the tree while it is still standing. Trap trees are not effective. In thin bark trees direct sunlight is effective in killing the broods.

Most feasible method of preventing attack on park or shade trees is by use of a mechanical protector or muslin or wire screen.

Repellents not effective.

Flight Habits

The history of several epidemics indicates that the progress of the infestation is at the rate of from ½ to 1 or 2 miles a year depending upon the distribution and amount of the available timber.

Attraction to Host

Beetles which breed in one tree species will continue to breed in this species with the exception that at the height of epidemics some aggressive individuals may break over into another tree species, in which they are known to breed.

Nothing is known as to why beetles attack certain individual trees.

D. monticolae is not drawn from great distances to trap trees of white pine.

SEASONAL HISTORY OF <u>DENDROCTONUS MONTICOLAE</u>
IN THE SIERRA REGION.
by

J. M. Miller.

In the seasonal history records kept at Ashland, Oregon, during 1915 and 1916, in sugar pine at elevations ranging from 2500 to 5000 feet, the main emergence from overwintering trees occurred from June 15 to July 15, the main period of attack following this emergence occurred during July, August and September, and the broods from this attack carried through the following winter as larvae, pupae and new adults. There was an average of but one annual generation. However, some of the overwintering adults emerged in May and early June and may have started attacks in June that completed brood development and emerged in September and October. This would indicate one complete seasonal generation and a partial second as the maximum.

In the Southern Sierra Region where records on the Sequoia National Park at elevations ranging from 5000 to 6500 feet were kept in 1918, it was found that trap trees were attacked during the period from June 10 to July 1, and that the emergence from these trees occurred during August and September. In trees which were attacked during the latter part of July and August, the broods overwintered as larvae, pupae and new adults. In this localith there is apparently a distinct summer generation as in the case of <u>Dendroctonus brevicomis</u> and it is fair to assume that there is a maximum of two annual generations with an average of one seasonal generation and a partial second.

In lodgepole pine of the Yosemite National Park region records kept in 1917 and 1918 at elevations ranging from 7500 to 8500 feet, it was found that the main emergence from the overwintering broods occurred from July 20 to August 1. Attacks from this emergence occurred from August 1 to September 15. The emergence of new adults from these attacks occurred during the latter part of July, August and September of the following year. Thus there is only one annual generation as a maximum. Some evidence was found to show that in the case of attacks which occurred during the latter part of September, the broods did not entirely complete their emergence by the following fall. This would indicate a partial biennial generation which occurs only rarely.

On the whole it seems safe to assume that the development of the broods of this species responds to the influence of temperature in much the same way as <u>Dendroctonus brevicomis</u>. The number of generations, ranging from one to two complete seasonal generations is determined to a great extent by the bioclimatic law. We find that local and regional as well as seasonal climatic variations produce a corresponding variation in the period of brood development and the number of seasonal generations.

DENDROCTONUS MONTICOLAE IN OREGON

Seasonal History with Reference to Variations Encountered
Under the Bioclimatic Law.
by
J. E. Patterson.

FOREWORD

The following notes on Dendroctonus monticolae in Oregon are based on data and notes obtained in the vicinity of Ashland and at Jenny Creek. The range in elevations at these places is between 2000 and 5000 feet. It is explained that most of the records were made at a mean elevation of 3500 feet; however, a limited number of records were taken at elevations below and also above this mean, so that we have some data on the seasonal history and brood development at all elevations intermediate between these extremes. It appears, however, after an alalysis of these records, that they are not conclusive enough to more than indicate the variations in seasonal history and development of the broods encountered under the bioclimatic law at the different elevations where these phenomena were studied.

Habits:

Dendroctonus monticolae attacks sugar pine, yellow pine, lodgepole pine, and western white pine, in Oregon. However, it seems to prefer sugar pine to the other species in the vicinity where these studies were made. Its habits in general are very similar to other species of barkbeetles. It seems to prefer weakened trees and slash material to healthy trees. However, it does attack and kill healthy trees of all of the above named species and under favorable conditions its ravages are sometimes very serious. These conditions are more noticeable in lodgepole pine stands and in thick stands of young yellow pine. Large group infestations in extensive stands of these two species have occurred in a number of localities in the state.

Seasonal History:

The seasonal history of Dendroctonus monticolae in the lower and mean elevations show that:

1. Overwintering stages:

The broods overwinter in all stages of development; though principally as parent adults, eggs and larvae with some new adults and pupae. (Based on occasional notes)

2. Emergence and attack:

Emergence of new adults from overwintered broods begins about May 1st, reaches a maximum about July 15th, and continues until October 15th. The principal period of attack is during August and September. As few attacks by the earlier emerging adults occur from June 1st to July 15th.

adults developing from these attacks emerge in September and October. Eggs are laid and some larvae hatch before winter.

3 - Hatching of eggs and development of larvae:

Eggs are deposited from about May 20th to the first of November. The principal period of oviposition is from August 1st to September 30th.

Larvae hatch and develop from May 20th to November 15th, the maximum period being from August 15th to October 15th.

4 - Pupae and pupal period:

Pupae begin forming about July 1st and continue to do so until late in October. The principal pupal period is from September 15th to October 30th.

5 - Annual generations:

There is a maximum of one annual generation and a partial second generation each year in the lower and mean elevations. The average is one generation each year. The principal event periods of the average annual generations are:

1 - Emergence and attack of overwintering broods- Aug. 1 to Oct. 20.
2 - Oviposition andeggs; Aug. 15 to Apr. 15 of succeeding year.
3 - Eggs hatching and larval period; Sept. 1, to July 1, of succeeding year.
4 - Pupae and pupal period; Aprl 1, to July 15.
5 - Emergence period; Aug. 1, to Oct. 20.

The principal event periods of the broods composing the partial second generation are:

1 - Emergence and attack of overwintering broods; May 15 to July 1.
2 - Oviposition and eggs; June 15 to July 15.
3 - Eggs hatching and larval period; June 15 to Sept. 30.
4 - Pupae and pupal period; Sug. 1 to Oct. 20.
5 - Partial* emergence period: Sept. 1 to Oct. 15.

*Part of the new adults of these broods do not emerge in the fall but overwinter in this stage and emerge the following spring. These new adults largely compose the first emergence of adults in the early spring period of emergence.

In the higher elevations, above 4000 feet, where the beetle attacks white pine, lodgepole pine, and also some sugar pine, the seasonal development is greatly retarded so that in these altitudes there is one complete generation and a partial biennial generations.

The principal event periods of the annual generations in these altitudes are:

The broods overwinter in all stages of development as in the lower elevations. The greater part of the broods consist of parent adults, eggs, young to full larvae, and a few pupae.

1 - Emergence and attack of overwintering broods: July 15 to Sept. 1.
2 - Oviposition and eggs: Aug. 1 to Nov. 1.
3 - Eggs hatching and larval period: Aug. 15 to June 15 of the following year.
4 - Pupae and pupal period; June 10 to July 30.

In some trees which are attacked late in August and in September the broods overwinter as parent adults and eggs, and these broods develop to pupae and new adults the next summer but do not emerge before the second winter. These broods emerge the second summer after attack and constitute a biennial generation. This generation represents from 9% to 27% of the broods.

In all elevations there is a continual overlapping of generations during the summer so that it is possible to find all stages on any one date during this period.

Statistics:

Parent adults have been noted emerging from a tree 36 days after attack.
The female makes the attack and is followed by the male.
Copulation occurs on the outer bark or at the entrance of the egg gallery. It is probable that it also occurs in the entrance of the brood galleries.
One male may serve as many as three females as this number of females have been found in one system of egg galleries with only one male in attendance.
Attack is not concerted but continuous.
Attack has been observed to last 28 days with a maximum of 5 days.
First eggs have been found 14 days after attack.
First larvae have been found 28 days after attack.
Females construct egg galleries at the rate of .25 of an inch per day.
Activities of the famales continue over night.

Event periods: *

First larvae to first pupae ----------------	26 days.
pupae to adults ------------------------------	27 "
Adults to emerging ---------------------------	27 "
First to last emerging -----------------------	29 "

Brood periods.*

Attack to larvae ----------------------- ---	50 days
Attack to pupae -----------------------------	76 "
Attack to adult ----------------------------	102 "
Attack to emerging ------------------------	129 "
Attack to last emerging ------------------	158 "

*These statistical data are for broods of the average annual generations in the lower to mean altitudes.

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Respectfully submitted,

(Signed) J. E. PATTERSON

SEASONAL HISTORY OF DENDROCTONUS MONTICOLAE
NORTHERN IDAHO.
by
J. C. Evenden.

During the past two seasons Mr. Rost, Entomological Ranger assigned to the Coeur d'Alene Station, has carried on rather intensive investigations relative to the seasonal history of Dendroctonus monticolae in white pine hosts. As this problem proved to be very complicated we are not ready to accept our findings as final, as it is believed that there will be variations to the data secured. Seasonal conditions undoubtedly have considerable influence upon the development of this insect and it is with this belief that we realize our data is subjected to criticism.

The results of the two seasons work have been graphically shown on the attached chart and a brief discussion follows: At this time that this investigation started (July 1921) the overwintering broods were just emerging and the first new attack was recorded July 10th. From the broods of this attack there developed approximately 60% new adults by September 8th, of which 50% emerged and attacked during the month of September. The remainder of these broods, 40% larvae and 10% new adults, overwintered in the trees attacked in July. The broods in the trees attacked in September overwintered as very small larvae, and emerged the following July.

The overwintered adults emerged during the early part of June and attacked. This attack, though it often takes place in weakened trees, windfalls, etc., is seldom successful due to the rather small numbers of beetles present in any one locality. The overwintered larvae, of the trees attacked the preceeding July, emerge during the last of June and the first of July and intermingle with the emergence from the trees attacked in September.

From this data we deduct that there is one and a partial second generation per year, and that the second generation is the most predominant.

MR EVENDEN: We are not ready to admit that there is only one and a partial second generation, but that is what our data points to at this time. In lodgepole pine we have no records, but I am very much of the opinion from examination of lodgepole pine infestations that there is one generation per year, because the elevation is approximagely from one to five thousand feet higher. You will notice that the seasonal event is much shorter than Mr. Patterson gave, the attack period is shorter - everything seems to be shorter than the length of time required by the Dendroctonus monticolae in Oregon.

DISCUSSION: Mr. Hartman brought up the subject of references to the bioclimatic law. Mr. Evenden stated that that was the substance of the title, but that he personally had no data except that he could say that the seasonal history in Idaho conforms each year to the development of certain plants, and that it was impossible there to carry on extensive observations for many reasons, one of which being time for the reason that, for one thing, on lodgepole pine infestations along the stream bottoms, one would have to cover an entire forest to get the infested trees at different elevations. Mr. Miller stated that the entomological records taken in the Southern Sierras were taken only at odd times, and that they had not been able to get over the territory on account of the pressure of control work, to follow up a systematic set of records. Mr. Keen suggested that it would be possible after assembling the different data to be presented to arrive at some conclusions relative to latitude, that it was that point intended to be brought out here under the discussion of the bioclimatic law, and not necessarily the altitude. Mr. Burke, in mentioning their findings in Northeastern Oregon, remarked that he did not remember that Mr. Patterson said anything about the beetles extending the galleries.

MR BURKE: Of course you cannot be certain about these beetles. The old adults always have already formed one gallery and leave a tree and go to another tree, then extend their galleries and lay eggs. The question is whether a partial second generation may not come from the old overwintered adults that have left one gallery and gone to another. There is a possibility of this.

CHAIRMAN: You found a continuation of galleries the following year on complete attacks and only in successful attacks?

MR BURKE: Well, only in the same tree. The broods were developing, along in the spring these same females were extending the galleries.

MR EDMONSTON: Late in the season the activity ceases, and when it starts again in the spring the female extends the gallery and deposits eggs. Sometimes the gallery will be half as long again.

MR PATTERSON: Referring to what Mr. Burke and Mr. Edmonston have just said, I found that Dendroctonus monticolae will extend galleries and deposit eggs in lodgepole pine, but have never found this in any other kind. Mr. Burke said that they had found it in yellow pine, the same habit. Mr. Evenden stated that they had never found it in white pine or lodgepole in Idhho, Mr. Jaenicke read a quotation from a magazine showing that this had

been found in lodgepole and yellow pine. Mr. Evenden said that it was very possible, but that still nothing had been said about white pine. The Chairman stated further that the editorial committee would probably work up the various data into a chart or table showing the findings under the bioclimatic law. Mr. Miller stated that his understanding of the biennial generations was that they occur where trees are attacked very late in the season.

MR MILLER: The attack may occur at those high elevations in the latter part of October, and apparently the adults do no more than start the eggs galleries and deposit a few eggs, and the development of the brood is stopped almost entirely through the winter and nothing happens until the next June. Then, when the snow leaves, and those eggs begin to incubate and start to develop. The new adults that finally develop from these eggs may still be in the same brood trees at the close of the season and will remain there until the second spring.

The Chairman stated that inasmuch as Mr. Patterson had touched on the subject of natural control and natural enemies, that they could also be included in the discussion. Further, that he had found entire groups of monticolae infestations in white pine stamped out by woodpeckers, groups of seven or eight or ten or more trees entirely stripped by woodpeckers. Also, that relative to beetle statistics, he had made a few gallery counts at one time and found no difference in the number of eggs per length of gallery, that a 28" gallery would have approximately the same eggs as a 27 or 42 inch gallery.

MR EVENDEN: A peculiar habit of the monticolae in lodgepole pine which I found rather accidentally was in looking over some old work of Mr. Wyman, who used to be in District One, where on the head of the Bitterroot River he marked a large number of trees which were infested in 1917. I could see these marks on the trees and no attention was paid to them until I noticed a lot of them were green. I wondered what he was marking green trees for. I found they had been attacked on one side, the attack was successful, and there had been an emergence and a strip of the green bark on the other side of the tree had kept the tree alive. Mr. Miller remarked that one vital point having to do with their methods of control on the Pacific Coast Region was to get further data on the life history of some of these predators, that they had found several other kinds that were predators on the western pine beetle and apparently on all of them. Mr. Burke stated that he had several records of predators of the mountain pine beetle. Mr. Edmonston stated that he had never found a pupae in the bark, but always in the ground. Mr. Person stated that he thought the same thing happened here, that he had not found a single larvae or pupae in a great amount of bark that he had examined. Mr. Evenden stated that there was a record made by some of the Forest Service at the time of the control work in Montana, and that it was his idea of these records that they showed that the pupae always occurred in the ground.

DENDROCTONUS MONTICOLAE, Hopk.

Life History, Beetle Statistics, Bark Counts, Natural Enemies.

By - J. E. Patterson.

FOREWORD

The following notes on Dendroctonus monticolae are based on life history records and statistical data taken near Ashland and Jenny Creek, Oregon, and in the Yosemite Park, California. While as a basis for supporting the points taken up in this memorandum these data are far from conclusive. They are, however, accurate so far as they go, to indicate the conclusions drawn and given herewith under the various heads of this paper.

The notes of the life history are brief as they have already been given to a large extent in the memorandum on the seasonal history of the species. In this paper they apply primarily to the average generation encountered in western pine forests at altitudes rangeing from 2,000 to 4,000 feet. Above and below these ranges, while the life history of the species remains essentially the same, the duration of brood and event periods are retarded or accelerated respectively, to a degree depending upon the range of elevations up or down as the case may be.

These statistics belong more properly to the paper on seasonal history and variations under the bioclimatic law where they have been discussed to a greater extent.

Life History:

The life history of Dendroctonus monticolae is given in periods of the insect's development, as:

1 - Overwintering Stages:

The broods overwinter in all stages, but principally as parent adults, larvae, eggs, with some new adults and pupae, in the inner bark of trees attacked the preceding summer and fall.

2 - Activity of Overwintered Broods, Emergence and Attack:

With the advent of warm weather in the spring the overwintered parent adults extend the egg galleries, which were not completed the preceding fall, and deposit eggs. The overwintered eggs hatch and the larvae shortly transform to pupae. The overwintered pupae early transform to new adults and these early new adults begin to emerge in April. The emergence of the overwintered broods is continuous from this time until the middle of October. The maximum period of emergence is from July 15 to October 15. Attacks on new trees are continuous from about June 1 to November 1, the principal

period is during August and September. The earlier emerging adults attack from about June 1 to July 15. Adults developing from these attacks emerge in September and October while some remain in this stage and overwinter in the trees. Thus it will be seen that there is continual activity during the summer months with a constant overlapping of event periods and generations.

3 - Hatching of Eggs and Development of Larvae:

Eggs are deposited from about May 1st to November. The principal period of oviposition is from August 1 to September 30.

Larvae hatch and develop from May 20 to November 15. The maximum period being from August 15 to October 15.

4 - Pupae and Pupal Period:

Pupae begin forming about July 1st and continue to do so until late in October. The principal pupal period is from September 15 to October 30.

5 - Annual Generations:

There is a maximum of one annual generation and one partial second generation each year in the lower elevations. In the higher elevations of the insects' range there is one annual generation and a partial biennial generation. The average in the mean elevations is one annual generation each year.

The principal event periods of the average annual generations are:

1 - Emergence and attack of overwintered broods - August 1 to Oct. 20.
2 - Oviposition and eggs - August 15 to April 15 of the succeeding year.
3 - Eggs hatching and larval period - September 1 to July 1 of succeeding year.
4 - Pupae and pupal period - April 1 to July 15.
5 - Emergence and flight - August 1 to October 20.

The attached life history chart shows these events periods for the average annual generation and also the variations encountered at elevations both above and below this mean.

Habits:

1 - Attacks:

The species attacks sugar pine, yellow pine, lodgepole pine, and western white pine in the regions studied. In the yellow pine-sugar pine forests of Oregon the species seem to prefer sugar pine to yellow pine. It also seems to prefer to attack weakened trees, such as lightning struck trees, trees in which an attack has already been made by other insects, and felled trees in preference to healthy trees. However, it is often found attacking apparently healthy trees

which exhibit none of the above conditions. Of the species of trees attacked sugar pine more often comes in this class.

The species is often associated in attacks on yellow pine with Dendroctonus brevicomis and Ips sps., and in sugar pine, white pine, and lodgepole pine, with Ips sps.

2 - Flight:

After the beetles have emerged from the parent brood trees flight occurs. Beetles have been noted flying during the day only but it is probable that they also fly at night. Data on the distance that beetles fly to attack other trees are not at all conclusive though it is known that they do sometimes fly a distance of at least onehalf mile. In attacking trees the beetles arrive singly or a number together. They fly straight against the tree striking the bark with a distinctly audible sound. After striking the bark they either cling to it or fall to the ground to immediately crawl up the trunk. The attack is not concerted but is continuous.

3 - Mating:

After the beetles arrive at a tree being attacked they crawl about on the surface of the bark in an undecided way for a few minutes before they begin boring into the bark. Mating and copulation have been noted to take place at this time. Copulation occurs on the surface of the bark and before the attack is made by the females. It is probable that it also occurs in the entrance chamber of the brood galleries after these have been started. One male probably serves more than one female as three females, attended by only one male, have been ovserved in one system of brood galleries.

Statistics: Bark Counts:

Data on brood statistics and bark counts of this species are extremely limited. However, some data of this nature were secured in connection with seasonal history studies at Ashland, in the Yosemite, and in the study of the Greenspring Highway slash. It is explained here that these data are far from conclusive and are taken to merely indicate certain statistics until such time as further studies along this line can be carried out.

Most of the following data were secured by removing the bark from infested standing sugar pine trees, and lodgepole pines:

Parent adults have been noted emerging from a tree 36 days after attack.
The female makes the attack and is followed by the male.
Attack has been observed to last 28 days with a maximum period of five days.
First eggs have been found 14 days after attack.
First larvae have been found 28 days after attack.
Females construct egg galleries at the rate of .25 of an inch per day.
Activities during attack continue over night.

Event Periods:

First larvae to first pupae ---------------------------- 26 days.
Pupae to Adults -------------------------------------- 27 days.
Adults to emerging ------------------------------------ 27 days
First to last emerging -------------------------------- 29 days

Brood Periods:

Attack to larvae -------------------------------------- 50 days.
Attack to pupae --------------------------------------- 76 days
Attack to adult -------------------------------------- 102 days
Attack to emerging ------------------------------------ 129 days
Attack to last emerging ------------------------------- 159 days.

The above statistics on event and brood periods are for the average annual generation.

Bark Counts in Sugar Pine:

Average attacks per square foot ---------------------- 4
Average P.A. per square foot -------------------------- 9
Average length of brood galleries --------------------- 30 ins.
Average number of eggs per square foot ---------------- 312
Average length of brood galleries per sq. ft. -------- 50 ins.
Average number of larvae maturing per sq. ft. --------- 180
Average number of pupae per square foot --------------- 140
* Average number of new adults emerging per sq. ft. ---- 60
* Average number adults emerging per each exit hole ---- 4

* The number of adults emerging from the bark cannot be determined by the same method used in the case of D. brevicomis i.e. by counting the number of exit holes, for the reason that more than one adult D. monticolae emerge from one exit hole. In these studies the pupal cells, which are apparent on the inner surface of the bark, were examined and counted. Each pupal cell not showing a dead larvae, pupa, or new adult, or parts of any of these forms, was taken as evidence that the adult of this cell had emerged. The emergence per square foot then was based on the number of clean pupal cells found in each section of bark of this size.

The above bark counts statistics show the following brood mortality and resultant effective progeny:

Brood Mortality:

Mortality between eggs and larvae maturing -----------42%
Mortality between larvae and pupae -------------------22%
Mortality between pupae and N.A. emerging ------------57%
Mortality between eggs and N.A. emerging -------------81%
Brood increase percent -------------------------------900%

Natural Enemies:

The following is a list of the known natural enemies of the species:

Parasites:

Cerambycobius burkei - Naked Chalcid larvae found with larval remains of host in galleries and pupal cells.

Medterus aldrichii - White Depterous larvae found attached to larvae of host in pupal cells.

Predators:

Clerus sphegeus - Pink Coleopterous larvae found under bark and in pupal cells and adults attacking adults of host on surface of bark.

Two species of woodpeckers, Xenopicus sp. and Melanerpes sp. prey on the broods in standing trees during the winter periods.

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Respectfully submitted,

(Signed) J. E. Patterson.

Ashland, Oregon.
January 26, 1923.

DENDROCTONUS MONTICOLAE

By - J. E. Patterson

ARTIFICIAL CONTROL.

In the artificial control of Dendroctonus monticolae in western forests a number of methods have been employed. It is the purpose of this paper to deal with these methods in a broad way rather than to give the details of procedure in the application of any of them.

As the species is very often associated in infestations with other species of barkbeetles, and as it is necessary in most control projects to combat all the different species involved in the losses, any scheme or methods of artificial control adopted must necessarily be effective against all the species contributing to the general infestation. Fortunately, for this purpose, the general life history and habits of D. monticolae are very similar to other primary barkbeetles, so that control methods effective against this species are also, with some slight modifications, effective and efficient in the control of the other species.

Recognized methods or artificial control of barkbeetles in western forests may be classified in the following two classes.

1 - Direct control methods.
2 - Utilization methods.

The direct methods of control involve the falling of the infested trees and the disposal of the broods by either burning the bark, or by removing the bark and subjecting it to the air or the the direct rays of the sun. These are by far the most effective and popular methods in use at the present time. This sort of control is accompanied by the loss of the merchantable timber in the treated trees.

The utilization methods involve any method whereby control is effected and at the same time the timber in the treated trees is salvaged. This method of control consists of logging the infested trees and either milling them and burning the slabs or by submerging the logs in ponds, rivers, or lakes which kills the infesting broods.

In the application of any of these methods care must be taken that the broods are killed before they transform to adults and emerge from the logs.

The utilization methods are applicable only when the infested areas are adjacent to sawmills, rivers, or lakes and where the expense of logging and milling is low enough to leave a margin of profit over marketing the lumber.

Any of the above methods are applicable and efficient in the artificial control of _Dendroctonus monticolae_.

Details of Artificial Control:

Marking and treatment of infested trees should not be undertaken before October 1, or later than June 30. Control work should not be attempted during July, August, and September, as the majority of the broods of beetles are either emerging from killed trees or attacking new ones during these months. Control work at this time would result in the disposal of only a small percentage of the broods.

In most western forests weather conditions during the winter months, December, January, and February, make control work impracticable during this period. Therefore effective control work against _D. monticolae_ is practicable only during the months of March, April, May, June, October and November.

In the control of this species it is not necessary to treat _all_ of the infested trees in an area of infestation. Treatment of groups of infested trees and accessible individual infested trees is all that is necessary to accomplish control.

Dendroctonus monticolae usually prefer weakened trees to those in a normal healthy condition so that this habit leads the species to attack lightning struck trees, windfalls, and slashed material in preference to healthy standing trees. Advantage may be taken of this habit in control work by providing such material to attract infestation from merchantable timber. This method of trapping the beetles may be employed to a certain extent with gratifying results. Trees used for traps should be trees of low merchantable quality such as crooked trees, trees with large spike limbs, trees in a decadent condition, in fact, any trees whose removal would benefit the forest. These trap trees should be felled in accessible locations where they can be easily treated and where they will attract the greatest infestation from the more valuable stands of timber. Trap trees should be treated by the same methods employed in the case of standing trees. They should be felled during the period when the broods are attacking new trees.

In treating _D. monticolae_ infestations in the different species of trees attacked by the beetle it is advantageous to employ the methods already given with some minor changes in technique in the treatment of the different host species.

The following outline of technique is usually employed:

Broods in Sugar Pine and Yellow Pine:

Infested bark of these two species must be entirely removed from the logs and the inner surface exposed to the air or sunlight. The bark may be burned although this is not necessary except in cases of combined attacks by _D. monticolae_ and _D. brevicomis_ in yellow pine.

Merely scorching the outer surface of the bark while it is still on the log is not sufficient to kill the broods.

Sugar pine and yellow pine trap trees are very attractive to the species so that this method of control can be used to good advantage and with good results in stands of these two species.

Lodgepole Pine and White Pine:

In treating broods in lodgepole pine it is only necessary to fall the trees and fire scorch the infested bark on the lower trunks. Owing to the extremely thin bark of lodgepole pine the broods can be killed with only a medium hot fire. In some localities where the midday period is relatively warm even fire scorching the bark is not necessary as the inner bark will dry sufficiently to kill the broods before they can develop and emerge.

The trap trees cannot be employed successfully in lodgepole pine infestations as the beetles very seldom attack down trees of this species.

In some localities where the bark of white pine is very thin infestations in this species can be controlled by the same methods which are effective in infestations of lodgepole pine. But in localities where the bark of white pine is thick the methods applicable to sugar pine and yellow pine must be used.

In the knowledge of the writer white pine trap trees have not been utilized in control work, so the efficacy of this method in white pine infestations is not known.

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Respectfully submitted,

(Signed) J. E. PATTERSON

Ashland, Oregon,
January 27, 1923.

CHAIRMAN: Do I understand that with lodgepole pine thin bark trees you didn't think it necessary to peel the trees?

MR PATTERSON: It isn't necessary when the midday period is sufficiently warm, to dry the bark.

MR CHAIRMAN: What diameter tree?

MR PATTERSON: As far as I know it doesn't matter as to the size of the tree. Any size, the bark of lodgepole pine is very thin. Mr. Evenden stated that in Montana they had found where there were infestations in lodgepole pine in trees below five or six inches in diameter the bark was so thin that after the larger trees had been killed out, allowing the direct sun to get in, the broods would dry out in this thin bark. Mr. Miller said that between five or six thousand lodgepoles treated in the Yosemite National Park none of them were peeled, stating that the reason was that it simply couldn't be done with any reasonable economy. The killing of the broods was accomplished entirely by scorching the trees, getting the dead limbs and deadwood around the trunk, and firing the whole pile; that this method was very effective. Mr. Evenden stated that in the Big Hole Basin in Montana, the Forest Service treated 23,000 trees, and peeled them at a cost of .23¢ per tree. Mr. Burke said that in Utah they peeled just as easy as yellow pine. Mr. Miller said that some of the Sierra lodgepole were forty inches in diameter, and that he didn't think it would be practical to peel a standing tree of that size. Mr. Evenden stated that there had been several lodgepole pine projects in Montana and that they peeled the trees there in some places, and in other places they slashed them in windrows, where they were a hundred percent killed. Mr. Patterson asked if monticolae attacked down lodgepole pine, that he had never found the down lodgepole pine attacked by Monticolae. Mr. Jaenicke said that he had observed this in Eastern Oregon and Western Washington. Mr. Evenden asked if they would consider a tree down when leaning at 45 degrees. Mr. Patterson said he had found one lodgepole pine prostrate on the ground, with the root system on side still holding, and that the tree was partially attacked. Mr. Burke said that in one case in northeastern Oregon in the fall of 1910, they felled a number of trees, but were unable to burn them on account of a heavy snow coming on, but that they scorched them and burnt the tops, but that they found the next spring that the broods in those trees were really further along than in standing trees. Mr. Burke stated that they had several methods there, depending on the tree; that the main part of the broods they were fighting were mountain pine beetle on yellow pine, where theycut the trees and barked them as is done now. With small yellow pine where the infestation was taken, they cut them down in windrows and burned them that way. That there were immense areas of yellow pine, 6 to 12 inches, that they peeled standing.

<u>MR KEEN</u>: I am particularly interested in knowing the flight of <u>D. monticolae</u> under average forest conditions, as it affects the practical working out of a control project. In this connection I would like to cite one instance I know of which apparently has occurred in a particular area, where the mountain pine beetle has flown a limited extent in a certain forest in the Warner Mountains, in the Modoc National Forest. There was a serious epidemic in the yellow pine. The infestation started in 1917 at the bottom of the canyon below Sugar Hill. It has been examined by Forest Service and Bureau of Entomology

officials from time to time and reports made on the situation. This last year some of the cruisers working under the Klamath Falls project made an examination of this area. A map I have here shows approximagely what has occurred in this locality. At the foot of Sugar Hill in the bottom of a canyon can be found the first evidence of the beetles in a small area of about 80 acres. In 1918, as shown by the reports of the cruisers, 75% of the trees were killed. At the present time there is a hundred percent killed in this locality. The following two year's loss, up to 1921, embraced an area of about 160 acres. The loss of the past year (1921) extended to about three hundred twenty acres. You can see how it extended in the concentric circles from the point of origin and simply spread out year by year taking an increasing circle around the old loss. At the present time it is becoming more or less scattered along the border of the new circle. In the middle of the area the yellow pine has been killed a hundred percent. There isn't a living tree left in that area. As far as I know this is our first record of such extensive damage to yellow pine in California from the mountain pine beetle where they have absolutely wiped out the yellow pine stand in the same way that they wipe out the lodgepole. I think the loss in here has been made possible thru over-crowding in a white fir stand on the north slope, and at the present time it is densely crowded. It is a case of the survival of the fittest, the yellow pine succumbing to the attacks of the insects. From these data it would appear very evident that this infestation has spread each year about a quarter of a mile from where it started. I am interested in knowing how many other cases are evident where we have a similar flight of the beetles under natural forest conditions, simply taking an increasing circle year by year.

CHAIRMAN: Discussions on this subject, please.

Mr. Miller stated that the case cited by Mr. Keen was the only one he knew of in California where they had found similar conditions in yellow pine, but that they had some records in the lodgepole where it seemed to be possible to trace a direct flight of the beetles and an advance in the infestation from one point to another. From certain centers in the lodgepole they had traced an advance of monticolae infestations following, instead of concentric circles, a definite advance in one direction.

DENDROCTONUS MONTICOLAE-Hopk.

Attraction to Hosts, Trap Trees, Slash, etc.,

By J. C. Evenden.

ATTRACTION TO HOSTS.

This phase of the subject carries with it two very important points which are the selection of the host, and the attraction of the beetles to certain individuals of that tree species selected. These two points will be discussed separately.

Host Selection:

The host selection principle is one which has caused more discussion than any other phase of forest entomology. The belief that the mountain pine beetle when once thoroughly established in one of its host plants will not emerge and attack another has been very difficult for many to believe. Though it is realized that practically nothing is known concerning the habits of these beetles from the time they emerge from one tree until they attack another, there is, however, a great deal of evidence that points to the soundness of this principle.

A very striking example of this evidence is the control work carried on in the Northeastern Oregon Project. A very small percentage of the infestation in yellow pine was treated which resulted in a reduction of the epidemic over a large area adjacent to lodgepple stands where an epidemic had existed before and continued long after the control work.

In the Blackfoot River Valley a very severe epidemic occurred in both yellow pine and lodgepole pine. Due to natural agencies the infestation in yellow pine died away to a below normal status, while the infestation in lodgepole pine has continued for eight years. The epidemic in the lodgepole pine stands has been so severe that in many regions practically all of the trees above 6" D.B.H. have been killed. At this time many of the beetles, for the want of favorable host material, were forced to attack the smaller trees in which the broods never develop due to the rapid drying out of the thin bark. As there still remained a large percent of the yellow pine stand, intermingled with and adjacent to these areas, it seems logical to assume that if these beetles had not become established to lodgepole pine, they would have gone into the other instead of attacking the smaller tree where a perpetuation of their species was impossible.

Inasmuch as we know that certain insects have adapted themselves to host plants from which they will not leave except under extremely adverse conditions, it surely seems logical that an insect which has several hosts can, by continuous breeding in one, become so established that it will not

seek a new host under normal conditions. To account for epidemics of the mountain pine beetles occuring in both yellow pine and lodgepole pine at the same time, I do not feel that there can be any doubt but that near the peak of an epidemic, when the beetles are aggressive and abundant, they will attack other species of their host plant. In making this change there will no doubt be a very high mortality before they can become thoroughly established in their new host. That there must be a migration from one host to the other, at certain times, seems almost necessary, for if this did not occur there would be developed varieties of the same insect, or even distinct species for each host. This belief, relative to the migration of the broods from one host to the other, during the height of their aggressiveness, surely explains the source of the yellow pine epidemic in the Blackfoot Valley, Montana, in 1914. If we accept this theory, with the possibility of a high percent of mortality during the change of host, it seems reasonable to assume that the infestation will not be as severe or as long lived as that from which the over abundance of beetles came. This could possibly be given as a reason for the cessation of the epidemic in one host and the continuance in the other.

As this principle has never been thoroughly tested by an actual control project, and in view of its tremendous economic importance relative to the recommendations for control of such infestations, and furthermore as I firmly believe in its soundness if properly applied, I recommend to this conference that the very first opportunity be taken for a thorough test of this phase of forest insect control.

Selection of Individuals of the Host Plant:

After a host has been selected there is a second choosing by the insects of an individual tree of this host to attack. During severe epidemics this selection of individual trees varies in many ways. The trees attacked may be in groups varying in number from five to one hundred or more, or there may be strips up mountain sides or along creek bottoms, or the infested trees may be scattered. During endemic infestation, due to the smaller number of trees attacked, there is a still greater appearance of a more careful selection by the beetles of a host tree. In the consideration of this problem there appears to be but two possible solutions which are as follows:

1 - Condition of the tree being favorable for insect attack.
2 - Mechanical, or chance selection.

Theories and idea can be advanced for the substantiation of either of these solutions, and in many cases the same data could be applied to both.

Though I realize that I have but a very foundation upon which to build my theory, I cannot help but believe that a combination of the two possible solutions would perhaps answer this problem. I believe that during an endemic period of an infestation the trees are selected for attack which have the least resistance, but that during an epidemic, while the beetles are aggressive and abundant, the selection of the individual tree is purely chance. In this connection I wish to quote from Prof. Stebbings, Forester and Entomologist of India, as follows; "It is often said that beetles, e.g. bark beetles, never attack a green healthy tree standing in the forest. This is a

complete falacy. In the ordinary balance of nature in the primeval forest, the bark beetle, whose offspring depend for their sustenance on the green bark or timber, will not attack a healthy tree. There is no necessity for it to do so. The balance of power is kept even in nature and the insect can always find a sufficiency of sickly trees whose death it hastens, or of green windfalls which provide the necessity of life, both for itself and its future offsprings. The foresters' business is, however, to remove all such blots from the forests and keep them clean. Also to raise per acre the largest number of trees possible. Given a year favorable to insect life, or a series of favorable years, and the number of a bark beetle pest in a forest becomes so great that they are bound to attack the green standing crop, seeking out, of course, the weaker trees to commence with. Vast numbers of the insects are killed by the outflow of resing or sap which the healthy trees respond to the attacks. This very outflow, however, reduces the vitality of the trees which gradually succumb to the enormous numbers of the foe attacking them, and the trees are in the end killed just as surely as if they had been girdled or felled by the forester."

The economic value that the solution of this problem will be to the practice of forestry is of course unknown. However, should it be proven that only the weakened trees are killed, then it would have a very decided influence upon the thoughts of forest insect control.

TRAP TREES

But very little time has been available for the investigation of the advisability of using trap tree during the control of Dendroctonus monticolae infestations. The only actual tests which have been made have been in white pine, and these have been very limited. A brief summary of the data secured from these tests and from field observations is as follows:

1 - Dendroctonus monticolae is apparently not drawn any great distance to trap trees.

2 - Dendroctonus monticolae may be drawn to the trap but will often attack standing trees near by.

3 - Trap trees to be entirely successful should be cut just before or during the period of flight for the following reasons:

   a. Trees cut for any great length of time seem to lose their attractiveness.

   b. If trees are cut for any great length of time before Dendroctonus monticolae emerge, secondary bark beetles, which emerge first, will have attacked the trap so severely that a subsequent Dendroctonus attack would be impossible.

4 - Windfalls are not usually attacked unless they are very close to infested trees.

Due to the meagerness of the data I realize that my deductions are questionable and must be regarded as tenative. However, at this time, I do not believe that

the use of trap trees in connection with the control of the mountain pine beetle in white pine would prove to be of any value.

SLASH, ETC.

As this phase of the subject will be covered in another paper, "Relation of Logging to Insect Control," it will not be included in this.

Respectfully submitted,

(Signed) J. C. Evenden

MR MILLER: You brought up the subject of host selection very appropriately. I believe that there may also be such a thing as selection of individual trees.

MR BURKE: It seems to me your problem would be a great deal like the other. Taking northeastern Oregon problem, you have an elevation with the white bark pine, a lower belt of lodgepole pine, and the lowest belt of all the yellow pine. All the records of Northeastern Oregon report heavy infestations of lodgepole. If through this lodgepole we have an endemic infestation of mountain pine beetle, and as you have an endemic infestation in lodgepole and an epidemic infestation in yellow pine, this host selection is based on the fact that some of these beetles get used to the lodgepole pine and stay with that. You practically have a development of a new species there. So that I should say that in that case while you might have had the same epidemic infestation of mountain pine beetle in the lodgepole, it was the aggressive beetles from the lodgepole that made your infestation in the yellow pine, and also in the white bark pine, and the evidence for that is that you practically had all the lodgepole killed before you had the infestation in the yellow pine. Same case in the Black Hills. You may have had an infestation all through the Black Hill of black hills beetles. When the epidemic started in the northern part of the Hills and went south. The result undoubtedly was that they developed aggressive broods in the northern part of the hills and went south. In the northeastern Oregon project, you should have had an epidemic coming right up. As a matter of fact it followed the epidemic in the lodgepole.

CHAIRMAN: That was not the case in the Blackfoot infestation. That will be brought out tomorrow. It started in the lodgepole pine, and a couple of years later it started in the yellow pine. It was confined to the lodgepole when it started, and as I say in this paper, it is still in the lodgepole, but there has been but little infestation in the yellow pine since 1915 until last year. During the height of an epidemic the beetles may leave a host and go into another? If we accept that theory we have to be very, very careful.

MR KEEN: We know that we can test them artificially. I carried out an experiment in Ashland by caging both yellow pine and sugar pine logs and taking beetles from the yellow pine trees and putting them in this. They went into both. They went into both being taken from either kind. On being given a preference they appeared to take the sugar pine instead of the yellow pine. It was, however, under artificial conditions and does not tell the story completely.

MR. EVENDEN: I know, I don't mean that I disagree with you in that case. I think both instances occur. We couldn't recommend to an owner that his lodgepole infestation isn't dangerous to his yellow pine. It is probably different in different places, and you can't make a general rule or recommendation.

MR EDMONSTON: I am sure that the beetles went from the lodgepole into the white bark. About the yellow pine, I don't know, because they were already in the yellow pine.

MR MILLER: We have found in California that we usually have one host to one species. I don't think of any area within this district where we might put the proposition to a test. I think the area that would be suitable for an experiment would be somewhere in the Northern District.

FLIGHT HABITS OF DENDROCTONUS MONTICOLAE

By
F. P. Keen.

In regard to the flight habits of Dendroctonus monticolae, very little is known.

All I have to offer on this subject is a very striking example of an intensive infestation in yellow pine pole stands which is occuring on Sugar Hill in the Warner Mountains of Modoc County, California. This infestation has been progressing for about six years and shows in a very graphic way how the infestation has spread in an ever widening circle from its original starting point. During these five years if there had been any general flight of the beetles it would seem reasonable to suppose that they would have selected scattering trees throughout the site all of which was apparently favorable to them. But they did not do this but contented themselves with taking each year a wider ring of timber surrounding the old trees and killing 100% of the trees as they went.

There are probably many cases of the progress of Dendroctonus monticolae infestations in lodgepole, which you will recall which also show this same slow progressive advance.

DENDROCTONUS PONDEROSAE

Seasonal History and Habits
by
W. D. Edmonston.

The adult beetles attack living and sometimes injured western yellow pine, lodgepole pine, limber pine, bristle-cone pine, Mexican white pine, and pinyon pine from the Black Hills of South Dakota, to Southern Arizona and Westward into Utah. Healthy middle-aged and mature trees are those most generally attacked; it will, however, attatk and kill trees from four inches in diameter up to the largest trees. It has a decided preference for living timber which makes it a primary enemy of the first importance.

It is unnecessary to comment on the destructive work of this beetle except to state that it is very much greater than any published reports have mentioned.

The adult insect is a stout, black, cylindrical beetle about one-sixth to one-fourth of an inch in length. It bores through the outer bark and excavates a long perpendicular egg gallery through the inner living bark parallel with or following the grain, grooving the surface of the wood. Along this gallery eggs are deposited at regular intervals or more often in groups of four or five; within ten days as a rule the larvae begin to hatch, thesx legless grubs excavate mines at right angles to the egg gallery, exposed in the inner bark and marking the surface of the wood. When full grown the larvae cease feeding and excavate a cell in the inner bark and on the surface of the wood, in this the grublike larvae transform to pupae exposed in the inner bark and in this cell transformation to the adult beetle takes place. In this manner the tree is completely girdled, which causes death.

After transforming to adults they remain for at least 52 days in their pupal cells. More often, however, they bore through the intervening bark, grooving the surface of the wood in the form of irregular cavities, where they congregate in small groups until ready to emerge. The emergence holes are through the outer bark, one exit hole answering for the emergence of numerous adults.

The principal emergence of the beetles is during August, but they continue to emerge and attack as late as October 25th, and possibly later, the altitude of the area governs that to a great extent, and there is only one generation each year.

The first evidence of attack on living trees is reddish boring dust in the loose bark and around the base of the tree followed by pitch tubes on the bark of the main trunk, more noticeable evidence is found in May and June when the foliage begins to fade, first to pale green and later to yellow, sorrel and red.

All stages of the insect from the egg to the adult is passed between the inner bark and sapwood, which it has been shown takes approximately twelve months, the living tissue or cambium layer must be healthy and free from disease, and remain so, I should judge, until pupation takes place.

It is entirely a matter of numbers of the pairs of beetles composing the attacking force whether they will succeed in establishing themselves or the pitch flow will drown them or drive them out. Many pairs of adults lose their lives in the initial attack, but as they are invariably followed by overwhelming numbers, the tree succumbs slowly, the pitch having been literally pushed out of the numberous entrance burrows, slows up, and ceases to obstruct the work.

If only injured, diseased and weakened trees were those selected, such trees could never be as numberous as they are; a casual walk through any forested region will or should convince the most sceptical that injured and diseased trees from any cause are not the most suitable from the standpoint of this primary barkbeetle.

I and others have time and again observed the recorded <u>D. ponderosae</u> areas of epidemic infestation which had persisted for many years, where the injured, diseased, and weakened trees had not been eliminated, as a matter of fact they appeared to be quite as numberous as they had been before and during the time, and after, when control work had reduced the infestation to the endemic stage.

One strong characteristic and fixed habit of this beetle is to concentrate in force and attack a number of trees in a clump, groups of three trees are common, in some cases as high as 350 trees have been found to compose the group.

Isolated clumps at a considerable distance, a quarter to half a mile or more from heavily infested centers are as a rule in groups of four to as high as eighteen trees. In nearly every case where isolated clumps have been found, a few trees on the borders of the clump show evidence of attack resulting in failure, 30 to 60 conspicuous very white pitch exudations scattered up and down the main trunk with dead adults adhering. This I can only attribute to lack of numbers of the attacking force.

MR. BURKE: I might say something about the difference between the Black Hills Beetle and the Mountain Pine Beetle. The thing that impressed me as being different is the larger and more abundant pitch tubes. We could spot the Black Hills Beetle infested trees by the pitch tubes. This species also attacks the trees more in large clumps. I was in the Black Hills five years after the first report, it was really before the height of the epidemic. The epidemic lasted from 1897 and I was in there again in 1908 and I made a thorough examination and there was about one-third of the forest dead; one could get up on a high point and look over and see great patches of green, red and black areas; at least one-third of the timber was killed.

THE CHAIRMAN: The next paper is by Mr. Edmonston, "Natural and Artificual Control."

(Here follows the paper read by Mr. Edmonston).

B. Dendroctonus ponderosae.

2. Natural and artificial control - By W. D. Edmonston

Natural control means an indefinite and in a great measure an unknown combination of factors. Climatic factors are outside the question and can only be made use of when we are carrying on artificial control, and the same applies to disease. We avoid treating infested trees which show a condition likely to result in at least partial destruction of the brood. Insectivorous birds are protected.

Parasites and predators so far as I know can only be considered and preserved under certain methods of control. The methods employed in the control of D. ponderosae favor the parasites and predators for the reason that burning is not necessary, and we figure that a large percent of at least the predators escape.

Take for example Enoclerus sphegeus, the larval stage is short, 60 days, after maturity they descend the tree outside the bark and enter the ground where they remain as prepupal larvae until the following year. The pupal stage is short; so also is the transformation to the adult. They spend at least eight months three inches deep in the ground at the base of the tree from which the D. ponderosae brood has emerged. I have taken as high as 28 clerid larvae from the ground at base of an abandoned tree. I figure that at least 35% of the clerid larvae escape. The larvae are quite active and can easily escape even in the immature stages; they have the bark on the stump and unpeeled portions of the trunk, top and limbs where they can find plenty of feed. When we have to use fire it is then a standoff and in that case we try and make a clean sweep of all the infestation.

There are two practical methods that have proved successful in combating D. ponderosae infestation one is to cut and peel the infested trees at the time when the larvae have developed sufficiently to loosen the bark, and that time on until mature adults predominate. Taking all factors into consideration the period from May 15 to July 15 covers the maximum limits of greatest efficiency.

The second method is to log the trees and burn the slabs. This is the most economical method, and when properly carried out always has resulted in reducing infestation to a low point. Furthermore, the work can be carried on from October of one year until July 15 of the next.

It is useless to go into details covering the two methods as both have to be worked out on the ground and no two projects are the same even tho the primary insect is the same.

Summary of Data Concerning
Dendroctonus ponderosae

Seasonal History and Habits

Attacks living and injured western yellow pine, lodgepole pine, limber pine, bristle-cone pine, Mexican white pine, pinyon pine.

Distributed from Black Hills, South Dakota, to southern Arizona and westward in Utah.

Principal emergence during August. One generation a year.

Attacks trees in groups of from 3 to 350 trees.

Work of this beetle characterized by large pitch tubes and group infestation.

Natural and Artificial Control.

Since burning of the bark is not always necessary, the method of control gives the greatest possible protection to the parasites and predators.

Two artificial methods used-

(1) Peeling the bark from the tree when the larvae have loosened it sufficiently. This can be accomplished with the greatest efficiency from May 15 to July 15.

(2) Log the trees and burn the slabs. This is the most economical method and can be carried on from October 1st until July 15th of the following year.

DENDROCTONUS VALENS
(The Red Turpentine Beetle)

By - R. O. Hartman.

Seasonal history and habits, damage (epidemics), association with other species, artificial and natural control. (Information from Dr. Hopkins' bulletins, G. A. Coleman and the laboratory files at Palo Alto). In the early literature was mistaken for D. terebrans (the black turpentine beetle.)

Seasonal History and Habits

The mature adults of Dendroctonus valens are found in all months of the year. The seasonal history seems never to have been definitely worked out, the generally accepted life cycle being placed at one year. G. A. Coleman, in his master's thesis, suggested that there may be two generations a year, while Dr. Hopkins states in some cases that they pass the second winter as adults. Of course, weather conditions is a factor that would make the life cycle variable.

This insect attacks various species of pine and occasionally spruce at or near their base. The female constructs its egg gallery from a few inches to several feet up above the base for 20' or down a foot or more beneath the surface of the ground, but always perpendicular with the grain. On healthy trees the evidence of attack is a large mount of pitchy frass at the entrance gallery, sometimes forming a tube 1" or more in length; on the less resistant trees these tubes are not formed but the red and white frass is always evident. The adults work in pairs, the male assisting in keeping the entrance clear of frass and resin. The adults are able to withstand a considerable amount of resin before they are drowned out. The eggs are deposited 1 to 300 along the edges of the gallery in a single row. The eggs hatch from 15 days to 6 weeks according to the season (February, March and April being cold it takes longer); in August, September and October they hatch in less time. Eggs and young larvae are found throughout the year but are most abundant from September 15 to November 15 and again in April and May. The larvae mine en mass at right angles to the parent gallery, without any individual larval mines. The larval period is from 3 to 7 months, April and May brood maturing much earlier than the September-October brood, since the latter pass the winter as larvae. Individual pupal cells are constructed in the bark. The pupal stage lasts from 15-25 days. The beetle does not always emerge at once on reaching maturity hence, while the ~~spring~~ brood may develop in 3-4 months, as much as 6-8 months m may elapse between the laying of the fall eggs and the appearance of the beetles from these eggs.

It is difficult to separate these periods of abundance sufficiently to say that there are two broods since one merges into the other so closely.

Damage

While in the forest this species is generally found to confine its destruction in a secondary manner with an occasional primary attack, in the native forest of Monterey pine at Pacific Grove and the planted groves of

Monterey pine in the vicinity of Stanford University, this species is of primary importance and has been classed as the most destructive insect to Monterey pine. Many trees of Monterey pine have been killed at Pacific Grove and only a few remain at Stanford University of the original plantings.

The attack on the trees extends from one foot beneath the surface to about 20' from the ground and is found very common attacking the stumps of recently felled trees and about one tree to every ten after felling.

Other conditions that may favor a primary attack are, drought, overmature, mistletoe, fungus, fire and a Dipterous sp. of Deplosis. Occasionally several attacks are made before the tree is overcome.

Fire-scarred trees in several instances have been noted to invite an attack on at least 2/3 of the burnt trees.

The attack is governed by conditions of the tree. If weakened the female bores unhindered, if healthy the flow of sap causes slow progress.

Association with Other Species

Ips plastographus, Ips radiatae, Ips confusus and Pissodes radiatae are usually found associated with D. valens in Monterey pine, their attacks sometimes following very close to that of valens and their mines quite often intermingle.

In the forested areas of the Pacific Coast and Rocky Mountains it is found associated with Ips emarginatus and Ips oregoni and practically all the Dendroctonus spp. except D. pseudotsugae, giving it a wide range and a large number of hosts.

Artificial and Natural Control

Valuable individual trees can be protected by cutting the beetles out of the bark as soon as their presence is indicated by masses of exuding resin mixed with reddish boring dust. Prof. Doane has tried injecting carbon bisulphide without definite results. G. A. Coleman has had satisfactory results with fumigants and kerosene.

One ounce of carbon bisulphide to each gallery; cost was 15¢ a tree.

Kerosene treatments, as with carbon bisulphide, were applied by opening the upper end of the egg gallery and injecting straight kerosene. The cost was 10¢ a tree.

Hydrocyanic acid gas (1 oz. com. sulphuric acid in 2 ozs. of water and 1 oz. potassium cyanide, 98%) to the tree which was encased with canvas, leaving 12 to 24 hours. This proved very successful, the cost beint 25¢ a tree.

Woodpeckers, nut hatches, parasitic and predatory insects and the little brown lizard all are factors in the natural control.

MR HARTMAN: As far as I can find out there is no real seasonal history that was conclusive. There was a suggestion from Dr. Hopkins that some of the adults very likely wintered over the two winters.

MR PERSON: I have done some work in Minnesota, and there they fly principally during May. Last summer I began work about the middle of June. At that time the eggs had been laid, and the attack had been completed, there were some very small larva. I followed the work through the summer and at the time I left the work late in September nearly the close of the season there, there were some larva left. It is quite conclusive up here that there is one annual life cycle. The trees they attack up there are principally Norway pine. In some of these as many as fifty or sixty attacks to a tree, whh which of course was plenty to kill the tree. The logging operations always seem to invite the attack.

MR MILLER: Brief summary of the Rogue River records. Apparently only one generation, annual life cycle. Apparently this species attacks every pine that I know anything about. The only immune native western conifers that I can recall now are the firs, but so far I failed to find any of the pines that are not attacked by this species.

CHAIRMAN: Have you found sugar pine attacked?

MR MILLER: Yes.

CHAIRMAN: I have no record of white pine.

MR PERSON: It attacks white pine in the East.

MR MILLER: I believe we have found it in Douglas fir, too, but I am not sure about hemlock.

MR BURKE: Has anybody found it in spruce?

CHAIRMAN: No, not that I know of.

MR BURKE: In regard to this as a primary species, we very often find that certain trees have been attacked but not killed. Usually when the tree is killed the Ips come in with the valens. Seems to me that the actual species responsible for the killing is the Ips that followed.

CHAIRMAN: We do not have such severe attacks in the north, generally they are confined to the base of the tree and are light attacks.

MR MILLER: It is a rather interesting point. I have noted some of those big trees in the Yosemite where the only evidence of any attack would be that of valens at the base. In the case of most of these trees we felled in control work we found something else the matter with them farther up, either an attack by one of the other pine beetles, Ips or Flatheads.

MR PATTERSON: ~~In~~ my work in the Yosemite I found a large yellow pine in the Yosemite Falls, Camp, a tree six feet in diameter at the base attacked by D. valens in May, as far up as I could reach. I didn't cut the tree at the time. Later on in June I did cut it. The lower trunk was attacked by

valens, this attack extended clear around the tree. I found a brood of brevicomis from about twenty feet up to the top of the tree. This brood of brevicomis was a new one, the attack hadn't been completed. It is a question in my mind which species killed that tree. I believe it was D. valens. I believe the tree was killed before the brevicomis attacked it.

Reference Reports:

Seasonal History and Habits of Miscellaneous Insects.

F. P. Keen - 1916.

SUMMARY OF NOTES ON *DENDROCTONUS VALENS*

Seasonal History and Habits

Seasonal generations variable from possibly two generations a year to one generation in two years. Average probably one generation a year.

Adults found at any time throughout year.

Attacks all western pines and possibly some other conifers.

Eggs are deposited in rows along the galleries. The larvae mine en mass without individual galleries.

Young larvae are found throughout the year but most abundant from September 15 to November 15 and again in April and May.

Damage

Usually secondary but does primary damage to Monterey pine in California. Favors fire scorched trees.

Control

For valuable individual trees cutting the beetles out and painting the wound with tar or creosote is the most effective remedy.

Carbon bisulphide, hudrocyanic acid gas, and kerosene have also been used with variable success.

NOTES ON IPS CONFUSUS

By

J. M. Miller.

The primary importance of this species lies in its capacity to attack and kill tops of larger trees and occasionally small trees in pole stands and reproduction. It is apparently a very common insect in slash and is easily drawn to traps cut at any season of the year.

Brood records were kept at Ashland, Oregon, during 1915 and 1916. Conclusions are that for that locality there are two complete seasonal generations. The attacks of the first seasonal generation occur during the latter part of March and throughout April from beetles which have overwintered as new adults. This attack goes into windfalls, logs, broken limbs, etc., which were caused by winter storms. The beetles of this generation emerge during July and August.

The second generation attacks tops of standing trees or young reproduction and pole stands during July, August and September. These broods develop to new adults before winter but do not emerge and carry through the winter in this stage.

The only other brood records we have are from the Sequoia National Park which were kept on three trees during the season of 1918. In trap logs attacked about June 10, new beetles were emerging by July 5, emergence continued until about July 25. These records indicate a shorter brood period than the Ashland records. In fact, this brood completed development in from 30 to 40 days. We do not have any second generation records from this region but this far have no data contrary to Keen's conclusion that there are but two seasonal generations.

As to the abundance of this species and its economic importance, we find a great deal of variation according to the region.

In studying the Rogue River epidemic in 1915 and 1916, we found that I. confusus was a very important factor in top-killed trees and in associated attacks with D. brevicomis. In the fall of 1915, about 800 trees were top-killed on the area, so far as we know all by this species. In every D. brevicomis tree that was felled we usually found an infestation of Ips in the upper 15 or 20 feet of the top. This condition so far as I know is pretty general throughout northern California and Oregon. In the trap trees cut on the Antelope project in 1920 I noticed that all were heavily loaded with Ips along the top and logs.

In the control work carried out on the Sequoia Park in 1918, we found very little top-killing and no amount of Ips confusus. In ten top-killed trees that were cut, Ips oregonis was found in only two of them. In the remainder the top infestation was either D. monticolae or Ips emarginatus.

When the San Joaquin project was started in 1920, a rather striking absence of Ips infestation in the tops was noted. We had almost no top-killed trees. The yellow pine were infested by D. brevicomis up to about the 8 inch diameter at the top, the remainder of the top would be entirely green. In the trap tree work during the summer a relatively small amount of Ips attacks occurred.

In the trap work in 1922, a close record was kept of the degree and amount of infestation drawn into the traps. Out of 113 traps, D. brevicomis was found in 101 and Ips in only 12. In relative quantity of infested bark, D. brevicomis loaded about 95% - Ips 5%.

On the whole the infestation of this species seems to be sporadic and local in character.

Reference Reports:

Ips confusus, Ashland Report 1916 - Keen.

MR PATTERSON: In regard to what Mr. Miller just said about Ips infestation in trap trees, we found on the Antelope project that the first set of traps placed in the spring of 1921, had been heavily attacked by Ips. Some were absolutely ruined, and a D. brevicomis attack crowded out by Ips.

MR KEEN: On the Southern Oregon project we have not encountered any Ips infestations to speak of. On certain areas where logging operations have been under way, there is a small amount of Ips confusus infestation, but it is practically negligible.

MR BURKE: When Mr. Herbert was working with the Forest Insect Laboratory a number of observations were made on Ips confusus. In a way, he agreed with Mr. Keen. That is, he concluded that there were four full generations and a partial fifth, just as I understaod Mr. Miller, the first three generations live in fallen stuff and the last generations of the season went into the living trees. Herbert's theory was that all of the slash was used up during the summer and therefore the beetles were forced into the living trees, during the winter there would be lots of fallen stuff and the beetles would go into this when they emerged in the spring. In his studies he found that the males made the nuptial chambers and very often started the egg galleries. Then the females came in. The average number of falleries to a nuptial chamber was five. Number of eggs was from thirty to fifty. In the studies that Herbert made he found that a generation would go through within ninety days. The period from the time the egg was laid till the adult was fully developed, usually was 80 to 90 days. He found that they attacked every month in the year except December, January and February. This is in the locality of Placerville, the middle Sierras. While we were at Placerville there was quite a heavy infestation of second growth trees. In this case we figured that evidently Ips confusus was the primary enemy.

MR HARTMAN: In the matter of contro., I would like to inquire as to the control of Ips confusus when the adults have fairly well matured. What is your method of control then?

MR MILLER: Burning is the only solution that I know of. Other methods, such as sun curing and just peeling, will work in the early stages of brood, but peeling will not work in the adult stage unless the adults are exposed directly to the hot sun. This seemed to be successful in a little experiment that we tried on the Figueroa area of the Santa Barbara Forest in 1922, but as a method of control it can't be considered for the reason that in peeling a log most of the adults will fall under the log and bark chips in shaded positions. Submergence of infested logs was attempted on the Arrowhead Lake project in 1922, but after 3 or 4 days of submergence it was found that Larvae, pupae and adults all revived. The success of this method is submergence is continued for a long period has not been proven.

IPS OREGONIS, Eich.

Seasonal History, Habits, Damage, etc.

By J. E. Patterson.

FOREWORD

The following brief notes on Ips oregonis were taken in southern Oregon at a mean elevation of 3,000 feet. As the species in this territory is largely associated with Ips confusus and other bark beetles, and as it has never been of much economical importance in the areas studied, it has therefore been given very little attention. The species is often confused with Ips confusus and as its life history, habits, damage, etc., are very similar to confusus the two species have very often been considered as one, and our notes have not, in most cases, been differentiated. For these reasons the following brief notes are very incomplete as is also our present knowledge of the species.

1 - Seasonal History:

The insect overwinters in all stages. Parent adults, eggs, larvae, pupae, and new adults have been found in yellow pine throughout the winter periods.

The overwintered broods commence to emerge about the middle of April and continue to emerge until the first of June.

The first attacks by the first seasonal generation are made during the latter part of April and are continued until June 15th. The new adults of this generation develop and emerge during July and August.

Attacks of the second generation begin in August and are continued until the last of September. This generation carried through the winter in all stages of development.

2 - Generations:

There are at least two annual generations of the species in the locality studied. One summer generation which carried through from May 1st to August, and one overwintering generation which begins in August carried through the winter and is ended in the latter part of May.

During the summer period there is a continuous overlapping of generations so that individuals in any stage of development may be found on any date during this period.

3 - Habits

The habits of the species are apparently very similar to confusus. It has been found attacking both yellow and sugar pine. The adults of the first seasonal generation seem to prefer down trees and trap material to standing trees.

The overwintering generation is usually found in standing trees. Ordinarily the species prefer the tops of mature trees or the entire length, of small trees. It has been found to kill large mature trees in restricted localities. However, as the species is almost invariably associated with either Ips confusus, Ips emarginatus, and the Dendroctonus beetles, it would appear that such association is a specific habit.

4 - Damage:

As before stated the habits of the species tends it to attack down material, tops of mature trees, and the entire length of small timber. It is known, however, to attack mature standing timber but, in its attacks, is almost invariably associated with other tree killing beetles. For these reasons its specific damage is hard to define. It is probably responsible, in a large measure, for extensive top-killing of mature trees in western forests and large group infestations in pole stands.

Epidemics occasionally occur in pine stands with the above mentioned results. These epidemics apparently have no close relationship as they occur at indefinite periods, with great fluctuations and in well separated areas or locations.

5 - Association with other Species:

The species is almost invariably associated in attacks and infestations with Ips confusus, Ips emarginatus, Dendroctonus brevicomis, and Dendroctonus monticolae.

6 - Statistics:

Attacks last 45 days.
Duration of emergence 44 days.
First attack to first emergence (summer brood) 54 days.
Attacks per square foot of bark - 20
Average length of egg galleries - 4 inches.
Average number of galleries per square foot - 40.
Average number of eggs per inch of gallery - 6.
Exit holes per square foot of bark - 42.
Average emergence per square foot of bark - 108*
Average number of beetles emerged per exit hole - 2.7

* This datum was obtained by examining the inner surface of bark after emergence. All the pupal cells which were clean and did not contain a dead larvae, pupa, or new adult, or parts of any of these forms, were taken as evidence that the new adult of these cells had emerged.

7 - Natural Control:

A certain amount of natural control is no doubt effected by insect enemies, birds, and bacterial diseases. However, practically no information is available on this head.

Only one species of insect has been definitely determined as an enemy of the beetle. This is a chalcid parasite which has been tentatively determined as a species of Roptrocerus.

Three species of woodpeckers, Xenopicus sp., Dryobates sp., and Melanerpes sp., are known to feed on the broods in standing trees. These birds do not attack the insect in down trees.

8 - Artificial Control:

Direct control by artificial means consist of treating the infested down material and standing trees by removing the bark and exposing it to the air which destroys the broods.

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Respectfully submitted,

(Signed) J. E. PATTERSON

Ashland, Oregon.
January 22, 1923.

MR BURKE: We had some notes on _Ips oregoni_. Mr. Herbert found it in the lodgepole pine along with the _Ips emarginatus_, and in the Jeffrey pine and yellow pine, also with the other varieties. In Northern Utah in 1917, one of my greatest problems was to try to trap the Black Hills beetle. All during the summer from the first of July until the first of September I cut trap trees once a week, but in every case the _Ips oregoni_ got ahead of the other beetle. The Ips would attack within a day after the tree was felled or girdled and the Black Hills beetle never got a chance.

NOTES ON SEASONAL HISTORY OF IPS EMARGINATUS

By - F. P. Keen.

As summarized from records taken at Ashland, Oregon, during 1915 and 1916, I have the following notes:

Counts made of number of eggs to an inch of gallery found 95 eggs in 14 inches or 6.8 eggs per inch.

Flight and attack was observed during May and June and again in August and September.

The beetles overwintered as adults, eggs and small larvae.

Records in two trees showed a brood period from first attack to first emerging of 70 days and a straggling emergence for 71 days.

There are apparently two generations a year.

On the Southern Oregon-Northern California, Ips emarginatus has been found very abundantly as a tree killing beetle on the Antelope Unit of Area 2 which is adjacent to a logged off area of the Algoma Lumber Company.

In one case a tree 40" in diameter with 6 logs was killed by this species. Upon felling the tree the three butt logs were found to be heavily infested with Ips emarginatus in the large stage while the upper three logs were still green with D. brevicomis just attacking and making entrance galleries. We usually think of Ips in connection with top killing and the killing of poles or limbs and D. brevicomis as primary destroying large trees, but here was a case where the normal order was completely reversed.

Attached is a photo of the tree mentioned above which shows how heavily it was infested with nothing but the Ips beetles.

Out of 49 trees treated during the week ending June 24, 1922, at this camp.

7	were killed by IPs emarginatus alone	
6	" " " " "	and D. brevicomis
14	" " " " "	and D. monticolae
1	" " " " "	and both D. brevicomis and D. monticolae
28	Trees or over half of the trees had Ips emarginatus as a species doing primary damage.	

At Klamath Falls, Oregon, at an elevation of about 4500 feet, first pupae were found about June 21, first new adults about July 11, emerging July 27. Their development is just about six weeks behind that of D. brevicomis in the same territory.

MR BURKE: I have made several observations on _Ips imarginatus_ and Herbert studied it. The life cycle was some 60 days. Herbert found galleries of 2 to 4 feet long, longer than most of the Ips galleries. In Oregon, in August, 1907, we found young beetles in the bark of trees killed by mountain pine beetles. In Utah I found conditions about the same, that was in July. There were a number of full grown larvae beetles under the bark. At this same time I found it killing one yellow pine. There were numerous large pitch tubes on that tree and no other insect under the bark. And in the fall work, the first work we did in Northeastern Oregon, out of about three hundred and ninety four trees, one tree was killed by _Ips emarginatus_. In the larger project we failed to get any records of _Ips emarginatus_.

MR MILLER: In the Sierra Region we find _Ips emarginatus_ mostly in the jeffrey pine, occasionally occuring in the yellow pine, but wherever we find any jeffrey pine infestations we are almost certain to find some _Ips emarginatus_ mixed in with it.

(Paper here to come from Mr. Burke).

MR BURKE: From all of our studies we have just about come to the conclusion that _Ips radiatae_ is probably secondary; you can always find it in suppressed limbs, but as far as we know, in Monterey pine, in Coast timber, I think _Ips radiatae_ is secondary. Mr. Herbert found that in the Sierras it also attacked the lodgepole pine. It is one of the group in which the primary galleries radiate from the nuptial chambers and the eggs are laid in fours, so it is very easy to distinquish for that reason. _Ips plastographus_ has always been given the credit of being the species concerned in the killing of the Monterey pine. We find in all cases now that it is _Ips confusus_, at least this is true around the San Francisco Bay District. Down at Monterey in the native growths we do find some _plastographus_. Probably one of the greatest examples of a miniature epidemic is just across the hills here in the Boy Scout Camp in the Monterey pine forests. These trees were planted about 25 years ago, three or four hundred acres. About two years ago there was an epidemic infestation in which a number of those trees were dying. In this epidemic the attacking insects were the _Dendroctonus valens_ at the base of the tree, and _Ips confusus_ and _Ips radiatae_ and also one of the pine weevils, _Pissodes radiatae_ at the tops. In all cases we come to the conclusion that it was the _Ips confusus_ that was the primary insect. The attacking insects are considerably mixed and we were not able to decide conclusively.

As with all these other species of Ips, the generations of _Ips plastographus_ are very variable. They will undoubtedly have four or five or maybe more generations per year.

MR MILLER: I would like to ask regarding these epidemics in Monterey pine if they show any tendency to persist longer than one year where no control work is done.

MR BURKE: Yes, they do. Some have been running for three years. It is a very interesting thing to try to decide how the beetles got into this locality. There is no native pine around about here at all. The forest was planted over 25 or 30 years ago. The question is how did _Ips confusus_ and the other four or five species, get in here, and did they all come together, or how? I think likely they came in wood - pine wood hauled in here. Otherwise they would have to fly thirty five or forty miles to get into this forest.

IPS RADIATAE AND IPS PLASTOGRAPHUS

By - H. E. Burke.

Ips radiatae, Hopk. Number of generations varies. Several each year. Makes several radiating galleries from a nuptial chamber. Eggs laid in groups of four in niches along the sides of the gallery. Attacks Monterey pine, knobcone pine and lodgepole pine.

Apparently secondary but sometimes kills trees.

In several epidemics in Monterey pine in the San Francisco Bay region, Ips radiatae was one of the species involved.

Associates with Dendroctonus valens, Ips confusus, Ips plastographus, Ips oregoni, Ips latidens and Pissodes radiatae.

Several epidemics have been controlled by cutting down the infested timber and burning it.

Ips plastographus Lec. Number of generations varies. Several each year. Makes several longitudinal galleries from a nuptial chamber. Galleries 6-8 in. long. Eggs laid singly in niches along sides of gallery. Attacks Monterey, lodgepole, bishop pine. Ips integer, which may be the same species, attacks yellow and western white pine.

Is primary under favorable conditions. Herbert found it killing lodgepole pine.

In several epidemics in the San Francisco Bay region it has been associated with Dendroctonus valens, Ips radiatae, and Pissodes radiatae.

Several epidemics have been controlled by cutting down the infested timber and burning it.

In the past this species has been credited with the work done in the San Francisco Bay region. During the past five years our records show that Ips confusus is the species involved at San Jose, Palo Alto and Oakland instead of Ips plastographus.

See reports by Herbert of Nov. 20, 1915 and December, 1916.

SUMMARY OF NOTES ON IPS BEETLES.

Ips confusus

Distribution: California, Oregon.

Host: Pinus ponderosa, Pinus radiata.

Damage: Kills tops of mature trees, pole stands and reproduction. Infestation sporadic in character. Breeds up in slash and trap material, fallen logs, etc.

Life History: Males make nuptial chamber and often start egg galleries. Average number of five egg galleries. Brood period egg to adult 80 to 90 days at Placerville, 30 to 40 days in Sequoia Park.

Seasonal History: At Ashland apparently two complete seasonal generations. First attacks latter part of March and through April. Emergence during July and August. Second generation attacks during July, August and September. These develop new adults before winter but these do not emerge but overwinter as adults. In sequoia Park broods completed development in 30 to 40 days. Apparently only two generations. At Placerville Herbert found four full generations and a partial fifth. First three generations live in fallen stuff, last generation goes into living trees. Attacks every month of year except December, January and February.

Parasites and predators

Control: Peeling trees sufficient to kill broods in early stages. Burning necessary when adults have formed. Submerging in water for six days not effective.

Ips oregoni - Eichh.

Distribution: California, Oregon, Washington, Idaho, Montana, Utah.

Host: Pinus ponderosa, Pinus jeffreyi, Pinus ponderosa scopulorum, Pinus lambertiana, Pinus murrayana.

Damage: Kills tops of trees, pole stands and reproduction. Epidemics are sporadic. Attracted to felled material, slash, etc. Usually associated with Ips confusus, Ips emarginatus, D. brevicomis, and D. monticolae.

Life History: Brood period first attack to first emergence 54 days at Ashland. Attacks per sq. ft. of bark 20. Emergence per sq. ft. 108.

Seasonal History: Overwinter in all stages, emergence 1st of April to middle of June. Attacks latter part of April to middle of June. These.

attack from August to last of September and carry through the winter. At least two annual generations at Ashland with a great overlapping of the various broods. First seasonal generation usually confined to down timber, overwintering generation found in standing trees.

Parasites and predators: Raptrocerus sp. Three species of woodpecks attack broods in standing trees.

Control: Peeling infested trees and exposing to air will kill immature stage. Burning necessary to kill adults.

Ips emarginatus

Distribution: California, Oregon, Idaho, Utah

Host: Pinus gnderosa, Pinus jeffreyi.

Damage: Kills mature and immature trees, breeds in down logs and slash.

Life History: Beetles overwintered as adults, eggs and small larvae. Brood period first attack to first emerging 70 days, straggling emergence for 71 more days at Ashland. At Placerville life cycle of 60 days.

Seasonal History: Flight and attack observed during May and June and again in August and September. Apparently two generations a year.

Parasites and predators:

Control: Peeling trees and exposing to air in immature stages. Burning necessary to kill adults.

Ips radiatae

Distribution: California

Host: Pinus radiatae, Pinus murrayana.

Damage: Associated with D. valens and Ips confusus, and Ips plastographus in killing Monterey pine, considered as secondary.

Life History: Primary galleries radiate from the nuptial chamber. Eggs laid in fours.

Seasonal History: Probably has four or five or possibly more generations a year.

Control: Controlled through felling and burning the bark or exposing it to air. Boy Scouts camp in Oakland hills an example of successful control.

FLATHEAD BORERS.

By - H. E. Burke.

Flathead borers are the larvae of the beetles of the family Buprestidae. There are two main groups: the barkminers which kill trees by mining through the cambium and girdling the trunk; and the woodborers which destroy the timber of the trees by mining through the wood.

In the past various species of barkminers have killed considerable coniferous timber in the West. Dr. Hopkins, in his first trip West in 1899, found considerable dead Douglas fir and white fir in the Cascade Mts. of Oregon killed by the western hemlock barkborer, Melanophila drummondi. Miller found the same species killing Douglas fir on the Klamath in 1911.

The first insect control work undertaken in California was conducted in 1905 against Melanophila gentilis in Jeffrey pine on the Santa Barbara Forest. This species also killed many yellow pine poles on the Trinity in 1911-1912. It also kills sugar pine poles and assists the Dendroctonus monticolae to kill the tops of the large sugar pine.

Melanophila californica attacks many species of pines and sometimes becomes a primary enemy especially in the second growth stands. Together with M. gentilis it was the specités involved in the killing of Jeffrey pine in the Swarthout Valley area of the Los Angeles County Camp grounds.

Another barkminer, Chrysobothris mali Horn. is one of the most important enemies of newly planted orchard, shade and ornamental trees in the West. Sometimes it kills as many as 85% of a stand during the first year. It attacks a great variety of deciduous trees and shrubs but does not attack conifers.

The wood borers destroy considerable timber, both that in the live trees and in trees after they have been killed by insects, fire or other causes. One of the most important wood borers is the western cedar heartwood borer, Trachykele blondeli Mars. This species attacks the timber of the western red cedar, Thuja plicata, and riddles it with worm holes which makes it unfit for many of the higher grade uses. It is particularly injurious along the lower Columbia River and in British Columbia. Another injurious wood borer is the small golden Buprestid, Chrysophana placida. This species attacks the wood of many species of conifers and riddles it with worm holes. It has attacked and seriously injured window and door casings after they were placed in buildings. It also mines the cones of some species of pines and damages the seed crop.

Some species of wood borers like _Buprestis laeviventris_, which mine the wood of stumps, are beneficial as they cause the quick decay of the wood and assist the settler in clearing the land. All of the species which mine under the bark and in the wood of fallen material may be beneficial because they assist in the early decay of the material which probably is a benefit to the establishment of a good second growth forest.

Cutting out and burning the infested parts are the best general methods of control so far developed. Repellents have been tried with _Chrysobothris mali_ and other species which injure living trees but so far as the writer has observed they are not a success. Craighead and Hofer have recommended piling in the sun to prevent damage by the mesquite flathead, _Chrysobothris octocola Lec._

See Yearbook 1909, Department Bull. 437, Farmers Bull. 1197 and Jour. Econ. Ento., Vols. 10-13.

LIFE HISTORY AND HABITS, IMPORTANCE, DAMAGE AND CONTROL

"CERAMBYCIDAE"

By - R. D. Hartman.

Life History and Habits.

Information from Dr. Hopkins, J. L. Webb, F. C. Craighead, H. F. Burke and the notes and records on file at the Forest Insect Laboratory, Palo Alto.

Cerambycids or roundheaded borers are so called to distinquish them from the Buprestids or flatheaded borers. The general appearance of the larva is that of an elongate, fleshy, yellowish-white grub, without distinct dorsal and ventral prothoracic plates, sometimes bearing three pairs of legs and sometimes without legs.

In some cases the borers confine their activity to the inner bark or cambium while in others they enter the sap or heartwood.

The eggs are generally deposited in bark crevices, however in some cases they are inserted deep into soft wood. In from 5 to 20 days after the egg is deposited the larva issued therefrom and immediately begins boring into the bark with which it finds itself in contact. The larva mines either the bark, the cambium, the wood or spends some of its larval period in all. The pupal cells may be constructed in the bark or outerwood, but in some cases the cells are found in the cambium or innerbood. The adults fly from April to October.

The life cycle is usually one year, however some species take two years or three years and occasionally longer. There is also a record of a partly second generation within a year.

"Importance."

Of the species that attack forest trees, the western larch bark bower (*Tetropium abietis* Fall.) is of primary importance on the Western larch, Douglas fir, white and red firs in Montana, Idaho, Utah, Washington, Oregon and California. The adults fly from April to September.

The eggs are deposited in clusters under bark scales. The larvae upon hatching mine the cambium and outerwood causing irregular and winding larval mines. When full grown the larva is about 1" in length. Pupation occurs both in the bark and outerwood. The adult emerges about one year after the egg is deposited and is an elongate brownish to black beetle from 3/8 to 4/5" in length. The principle time for maximum emergence is May and June.

There are also two species of cedar tree borers formerly belonging to the genus Hylotroupes (Hemicallidium amethystinum Casey) and Anacomis lignea var. ampla Casey) are at times found killing healthy trees.

They are found associated in incense cedar and giant arborvitae and the latter also infests Arizona cypress, white fir, Alpine fir, Western hemlock, Englemann spruce, juniper and the two species of redwood.

The adults of both species fly from March to October. The larvae mine the inner bark and wood and pupate in outerwood or bark of thick barked trees.

The adults of the first species range from ½ to 1" in length and the wing covers are generally steel blue, while those of the second species are from ½ to 2/3" in length and the wing covers are generally marked with transverse bands of red and black.

"Damage."

The larvae of several species of the genera Monochamus, Leptura and Ergates undoubtedly cause considerable damage to the sap and heartwood of fallen insect and fire-killed timber and in a few years time so thoroughly riddle the timber that it materially reduces its value from a commercial standpoint.

In the construction of rustic buildings not a little damage has been experienced by the larvae of a number of species of bark and wood boring insects (including some Cerambycids.)

In shade and ornamental trees numerous species are of economic importance.

"Control"

The remedy (as with all insects) depends upon the habits and character of work of the species under consideration.

The control of the primary species would be in the felling and treating by burning or exposure before the brood entered the wood.

In the case of those living and feeding in the cambium(as with Rhagium and Acanthocinus?) they can be materially reduced by peeling the infested trees and exposing the brood before they change to the adult stage, when the bark can be easily removed. Such species,however, will not injure the wood.

Since by far the most damage caused by roundheaded borers to timber in the Pacific Coast Region is in the form of recently killed or fallen timber and since the eggs of these destructive species are generally deposited upon or within the bark during the late spring, summer and early fall months, an effective measure of control should be in the barking of such timber before or soon after the eggs were deposited. Of course timber so injured during the late fall and winter months would not require barking generally until

April. Other methods are: floating logs in water within a month after cutting, covering the logs thickly with brush or possibly spraying with creosote and kerosene may prevent an attack.

"Cerambycid Notes from Mr. Burke's Records."

Identified by J. L. Webb, E. A. Schwarz and W. S. Fisher.

Rhagium lineatum Oliv. Abies concolor (adult on trunk)

D.F. Meredith, Wash., and Summerdale, Calif. June (Burke)
L.P. Kamas, Utah. June (Burke)
L.P. Kamas, Utah, and Joseph, Ore. September (Burke)

Zylotrechus undulatus Say.

D.F., A.F. Kent and Paradise Valley, Wash. June, July, August (Burke)
A.F., D.F., L.P., Kamas, Utah. July, August, September. (Burke)

Monochamus scutellatus Say.

A.F., Paradise Valley, Wash. August, September (Burke)
A.F. D.F., Kamas, Utah. July, September (Burke)

(Hylotroupes) Anacomis lignea var. ampla Csy. (Ligneus Fab.) Thuja plicata

Associates with amethystinum D.F. Kent, Wash. (Burke)
D.F., A.C. Sequin, Wash., Summerdale and Big Tree Grove, Mariposa, Calif., Kent, Piclschie, Wash. (Burke)
Alpine for. Kamas, Utah. June, September (Burke)

Ergates speculatus Lec.

L.P. Summerdale and Yosemite, Calif. August (Burke)

Monochamus titillator Fa. Southern Pine sawyer.

Asemum atrum Esch.

L.P. Kamas and Panquitch Lake, Utah. June, July, August (Burke)
L.P. Baker, Ore. June (Burke)

MR JAENICKE: The problem of cerambycids is rather an important one in the Northern Rocky Mountain region, and in the Pacific Northwest, in connection with the deterioration of fire killed timber. In 1910 and 1911, a study was made by the Forest Service to determine how rapidly fire killed timber deteriorated because of fungus and insect activity. It was found that checking and activity of fungi destroyed the value of the sapwood in a few years but that probably the heartwood of the various species would more frequently be of value for a long time were it not for the activity of round-headed borers. The insect aspect of this deterioration problem was made by J. F. Pernot of the Forest Service. The results of the study are given in the following paragraphs.

CHAIRMAN: I might say in connection with that, that lumbermen are not so much concerned in the destruction of heartwood as they are of the sapwood. There was a tremendous fire this year in the white pine stand of the Rutledge Timber Company. They immediately made plans to salvage this material but they found that soon after the fire there were borers eating in this pine, causing a further loss of thousands of dollars in this product.

Summary of Notes on Epidemics.

Definitions.

Endemic infestation or "normal" infestation is one in which only a normal amount of loss occurs each year confined principally to the old mature over ripe, lightning struck, fallen or injured trees. This loss rarely exceeds five tenth of one percent of the stand.

The point where an infestation ceases to be endemic and becomes epidemic can be expressed in number of trees killed per section per year providing the character and density of the stand is taken into consideration. Such an index will be different for each locality, unit or project and should be stated when speaking of a particular locality. Thru the Sierra region of California 10 trees per section was used as the index, by Hopping. Patterson and Antelope used 25 trees per section or .4% as endemic. On the Southern Oregon-Northern California project 30 trees, per section or a maximum of about 5/10 of 1% of the stand is used as the index. D. ponderosae in Colorado and Arizona 15 to 35 trees per section called endemic.

Epidemic infestation is one in which the insects are killing healthy trees, both in groups or singly, in excess of what would be considered a normal or endemic infestation.

Epidemic infestations are classified as increasing, balanced, or decreasing depending upon the change in intensity in any two consecutive years.

Causes - Very little is known as to causes of epidemics. Some of the causes which have been associated with certain epidemics are as follows:

1. Fire

   Light burning when trees have been left weakened.
   Examples - Mistletoe and Siskiyou burns at Ashland 1916-1917
   areas adjacent to Southern Oregon project 1921.

2. Windfalls.

   There appears to be a connection between windfalls and certain sporadic epidemics either thru breeding up large numbers of destructive beetles or thru the attraction to beetles to the general locality.

Examples - It has been noted many times that traps draw beetles to the locality of the traps and cause attack on adjacent standing trees.

California Forest Infestation 1922. Possibly due to drawing power of large windfall on the area.

Rogue River epidemics of 1915 followed heavy windfalls thru the area.

3 - Slash

Probably slash acts in the same way as windfalls in drawing the infestation to the area. However, whether an epidemic will result or not depends upon other factors.

(a) That is if logging is continuous, plenty of slash is available and no epidemic in standing timber results.

Examples - Coconino National Forest, Arizona, continuous logging very free from infestation within three miles of the logging operations.

Logging in Coeur d'Alene National Forest following 1910 fires resulted in a decrease of infestation.

(b) That if logging is sporadic and trees left on ground through the summer results are usually bad.

Examples - Arling, Idaho, in Payette River Valley farmer operated mill during summer since 1908, logs cut in spring left during summer in woods, removed in fall, resulted in loss of fully 15% of stand in 5 years.

Algoma cutting on Antelope Unit, area 2, Southern Oregon-Northern California project at cessation of cutting beetles attack standing timber in vicinity.

4 - Other Factors.

These are more important and far outweigh all other causes so far indicated.

Examples - Kaibab Forest. Very heavy epidemic virgin forest far from any influence of man, no fires, and no windfalls or slash.

Area 3, Southern Oregon- Northern California project. Very heavy epidemic as high as 4% of stand in one year, no logging, no windfalls, no fires or other apparent causes for this.

Barkbeetle Epidemics

By

J. M. Miller.

Epidemics compose our major problem in the protection of Forests from insect depredations. So long as the low endemic condition endures insects interfere but little with the production of crops of timber. It is the epidemic of barkbeetles or defoliators which not only effsets the entire animal increment but may also bring about a very appreciable reduction of the forest capital as well.

If the basis accepted for the point where the endemic ceases and the epidemic begins at a certain degree of loss, shall it be a certain number of infested trees per section or a certain percent of the stand killed annually.

In the California suvey of 1917 which covered 1,682,000 acres of pine type in the southern Sierras, and about 19 billion feet in volume, it become necessary to assume some basis of classification for the various units which were outlined. The following definitions were used.

"Epidemic infestations are those in which the insects are killing healthy trees, both in groups and singly, usually exceeding annually a certain percentage of the stand such as one tenth of one percent of the timber. Normal or endemic infestations are those in which the insects attacks are usually confined to unhealthy, lightning struck or injured trees, although occasional healthy trees may be killed. In an endemic or normal infestation the loss is rarely in excess of one tenth of one percent of the stand." In addition both epidemic and normal infestations were classified into increasing, decreasing and balanced. By balanced is meant the condition in which the loss has remained fairly stationary during the past two years.

In other projects, and I believe this includes the Southern Oregon-Northern California project, the number of infested trees per section is taken as the index of the epidemic or normal endemic condition. In a good many control projects in California, especially those carried on by Mr. Hopping, the number of trees per section have been used as an index. Hopping termed any infestation in which the number of infested trees per section exceeded 10, as epidemic.

Causes of Epidemics

We really know so little about the underlying causes of epidemics and their natural control that nearly everything we can give about them is mere speculation. We do not know why for long periods of years at a time the infestation may remain endemic with only minor fluctuations of increase or decrease. We do not know why infestations may suddenly increase 600 or 800% in one season, nor why after a year or two of these sudden increases they may almost as suddenly decline again to endemic.

It is true that we have some knowledge of the factors that contrubute toward increase and decrease and most of us have beliefs as to what may have been the underlying causes of certain epidemics, but I doubt if any of us can conclusively prove our contentions. There is much conflicting evidence both ways as to the influences which have caused some of these epidemics.

Among the factors commonly believed to influence the increase or decrease of infestations are the following:

1. Weather conditions:

   Drought: We have yet to record any specific epidemic which resulted from a period of drought. Epidemics have developed however in years of normal or excessive precipitation.

   Temperature: No correlation has been established between epidemics and abnormal temperatures, or seasonal periods altho it is apparent that an unusually long warm season increases the breeding period of the beetles.

2. Fire:

   Relation of fire to a certain type of epidemic condition has been pretty definitely established. Beetle attacks concentrate within the moderately scorched trees of a burn. This will bring about a concentration which results in a local epidemic within the burn. This condition usually subsides within the second year after the fire. It apparently does not spread into the surrounding region or develop into a widespread epidemic.

3. Slash and Windfalls.

   There is apparently some association between slash conditions and epidemics, where beetles emerging from quantities of down logs in which they have been breeding, attack standing trees when fresh slash material is absent. However, some of the most conspicuous epidemics have developed in the absence of any slash conditions, and frequently slash conditions like those referred have failed to develop any appreciable epidemics.

4. Other Factors.

   Predatory and parasitic insects, wood peckers, etc. These are the factors commonly believed to maintain the natural control of infestation. When these factors fail to maintain the necessary balance the epidemic follows, and it is these same factors that will eventually reduce it. This phase of the problem is but very little understood and should be made the subject of adequate investigations.

Specific Epidemics
In Calif.

Areas upon which we have satisfactory or detailed information are few and far between. Even where the epidemics have been studied and records made the actual extent of the area involved is not known. In going over the reports of the California areas, I find that we have some fairly specific information on the following:

Klamath Area

Total area included ----------------------------255,100 acres
Total volume ----------------------------------951,952 M. B. ft.
Period of records - 1914-1917.

Primary insects

D. brevicomis. So far as records give us the information this species was responsible for all of the killing of yellow pine. The total killing each year was above 90% of the combined loss of yellow pine and sugar pine for the area.

D. monticolae. Found principally in sugar pine. Loss amounted to from 3 to 7½% of the entireloss on the area.

Record of Losses	Volume Killed	% of Stand	Increase %
1914	823,500	.08	
1915	2,714,500	.28	- 246
1916	880,500	.09	- 66
1917	589,600	.06	- 33

California National Forest.

Area not known - Estimated to cover 200,000 acres.
D. brevicomis in yellow pine.
D monticolae in sugar pine
Epidemic runs ~~xxxxxxxx~~ coordinately.
Epidemic came up almost entirely in 1922, loss probably close to 100,000,000 feet.
On check area. % killed 1922 5.6%
Nearly all of loss resulted from 1922 summer brood attacks.

MR. MILLER: I wanted to indicate one instance where there was a really sudden and pronounced jump. It occurred this year. The increase in California has been one of the most pronounced that I have ever seen in my experience. The Western Pine Beetle has increased 600% of 700% in one season. How long that is going to last, I don't know. There was an endemic infestation in the area before the sudden increase. In 1922 that suddenly increased to large groups of 50 to 100 mature trees and it killed them within the period of two or three months during the summer.

MR EDMONSTON: We have that, say, 250%; it is a gradual epidemic state. Now your 400% or 500% increase undoubtedly comes from the surrounding territory. It doesn't jump from an endemic to an epidemic in one year. The D. ponderosae is not known to do that. I can't swallow these sudden things.

MR JAENICKE: Increases amounting to several hundred percent in single years were quite common in the northeastern Oregon lodgepole, yellow pine infestation by the mountain pine beetle. In 1910 and 1911 this infestation covered large portions of several National Forests while in 1905 the mountain pine beetle infestation was in a quiescent condition. In other works, in the brief space of five or six years, this infestation had developed from an endemic infestation to a depredation which killed a considerable part of the timber on several hundred thousand acres. There seems to be two schools of thought on the origin of the beetles responsible for epidemic infestations in a given area result from the rapid increase of the beetles already existing within the area. Other observers maintain that the epidemic infestations may be due to the influx of beetles from surrounding areas which come from the outside. The settlement of this question is important for our control work because our conception of what a complete and independent insect control is, depends largely on the origin of the beetles responsible for epidemic infestations.

MR MILLER: In the spring of 1921 a very heavy windfall condition occurred amounting to twentyfive million feet of timber, within an area of perhaps fifty or sixty thousand acres. occurred in the western part of the California National Forest. The opinion of some of the forest service men who were interested is that conditions was that they would get an increasing infestation on account of windfalls within that area, and in the summer of 1922 it began to be very evident that increase was developing, and by the fall of that year it had developed into one of the most comspicuous epidemics that we have ever had in the district. It was accepted by a good many that it was due to windfalls in some way, that the insects had breed within the windfalls and had gone into the surrounding timber. In the survey that was made we found that the infestation was very heavy around the windfall area., but equally as bad in areas many miles away from the windfalls. It was a case of a very wide-spread epidemic, not much worse around the windfall area than it was anywhere else. In looking through the conditions of that windfall, which was not done very thoroughly, it was very difficult to find much evidence of any Dendroctonus beetles breeding within that slash. Once in a while we found a log in which the western pine beetle had developed a brood. There was evidence of some Ips breeding in the slash, but in all of the groups of trees examined that had been killed anywhere near the slash, we could find nothing but western pine beetle infestations. No Ips were in evidence.

MR BURKE: Mr. Miller, did I understand you to say you wouldn't control an epidemic at all?

MR MILLER: I would not unless because of very high values, intensive forest protection is desired. In the case of Park and Shade tree situations you would probably want to consider the control of endemics. In the protection of merchantable timber we are concerned only with maintaining and increasing the present volumes and as a rule endemics do not interfere to any great extent with that sort of protection. In the yellow pine, sugar pine type of the Sierras, the mature timber averages about 200 years of age. Under our usual endemic condition we always find a loss from insects that is less than a half of one percent of the stand annually. If the rotation of two hundred years is right, and you kill a half of one percent annually you are killing just the average increment, and your forest will stand at the same volume indefinitely at that rate. It is a fact that an endemic may become epidemic, and that fact makes it a menace in our pine stands, and that is why I think that the Forester is concerned with the endemic. Another point is the value of the few mature trees that are being killed by endemic infestation. If we are to carry on maintenance control we will have to treat endemics. Those mature trees contain a high volume of clear timber value, and each individual tree is worth just so much in stumpage value to the owner. If he can save it for 5, 10 or 15 years until he can turn it into lumber, it is better than growing another tree to replace it.

MR BURKE: There are undoubtedly a great many factors in this, and I think I would agree with Mr. Miller providing we had all the forests under forest conditions, but it seems to me as far as the endemic goes, we are in the same position as the epidemic. Looking at it from the standpoint of merchantable timber, we are going to need all the timber we can get, does not make any difference whether it is old and mature or not. We certainly have records where an endemic infestation has really killed more timber in twenty years than the epidemic does. Of course, there is a question of whether we can control endemics, but it seems to me if we are going to undertake any control at all it is well worth while to control endemic infestations. Taking the entire case as a whole, I think we are losing twice as much timber through endemic as epidemic infestations.

MR JAENICKE: In the present intensity of forest administration it seems to me that for the time being we can afford to pay attention only to epidemic situations and those infestations which bear evidence of becoming epidemic.

CHAIRMAN: I don't think anyone here has an idea of neglecting the epidemics, but where would your epidemics be if we controlled the endemics.

NORTHEASTERN OREGON EPIDEMIC.

By - H. E. Burke.

Introduction: First known through correspondence with private owners. Field inspection by Forest Assistant B. T. Harvey, Forest Ranger, R. E. Smith and experts H. E. Burke and W. D. Edmonston, of the Bureau of Entomology. Trips were made through the timber and certain areas were cruised carefully. Observations were made in August, 1907, and May 10, 1910 to July 1, 1911. Recruises to check results were made in 1912 by Edmonston, Hofer and Smith and in 1913 by Edmonston and Hofer.

Location: Northeastern corner of Oregon in the Whitman and Wallowa National Forests and adjacent private lands.

Extent of Area: About 75 miles wide, 125 miles long; nearly 4,000,000 acres, 1,000,000 of which is yellow pine.

Timber Resources Involved: Yellow pine is of good quality, merchantable, fairly accessible, most of it will be cut in 25 years, Cutting was going on at the time of the infestation and has continued. $456,500 was received by the Forest Service for stumpage sold in the area during 1918-1920. Considering that at least three fourths of the yellow pine is in the hands of the private owners, the total stumpage value of the timber was at least $10,000,000.

Cause of Epidemic: The mountain pine beetle (Dendroctonus monticolae) was the cause of the epidemic. It killed yellow, lodgepole and white barked pine and attacked some Englemann spruce. The western pine ~~xxxx~~ beetle (D. brevicomis) was secondary except in a few cases where it killed yellow pine. D. pseudotsuga was killing Douglas fir and D. englemanni was killing Englemann spruce at the same time. D. valens killed some lodgepole in one locality near the timber line.

Cycle of Epidemic: The epidemic started in 1905 and continued with increasing vigor until 1913-1914. The control work was done during the fall of 1910 and the spring of 1911. Cruises by Smith, Edmonston and Hofer in 1913 and 1914 showed that in the area worked there was some decline in the infestation but outside of this area there was no decline. After 1915 the epidemic declined rapidly.

Cause of Decline of Epidemic: If the percentage theory of control is correct the control work of 1910-1911 may have been the cause of the decline.

See reports by Burke: Proceedings Ent. Soc. of Wash., V IX (1907) p. 115; July 11, 1910; Jan. 12, 1911; June 28, 1912; Edmonston Nov. 30, 1910; Dec. 1912; Hofer, winter of 1913; R.E. Smith, July 1, 1910; Nov. 19, 1910; W. T. Andrews, July 6, 1910; L. D. W. Shelton, July 25, 1911.

PROJECT 15 a - ROGUE RIVER AREA, ORE.

Epidemic of Dendroctonus
Brevicomis in Yellow Pine
By
J. E. Patterson.

OUTLINE OF HISTORY OF THE EPIDEMIC TO DATE.

1. Introduction:

A study of an epidemic of Dendroctonus brevicomis in yellow pine in the Rogue River Area of Southern Oregon was undertaken by the Ashland Station in 1914. Owing to the value of the study and the probable applicability of its results to other areas it has been continued and is at this date still under way.

The information compiled in the following memorandum has been secured by making annual surveys of the area. A list of the parties contributing this information is herewith given: with the period of their observations:

J. M. Miller	- 1914 to 1917 Incl.
F. P. Keen	- 1914 to 1916 Incl.
J. D. Riggs	- 1915
W. E. Glendinning	- 1915 to 1917 Incl.
A. W. Wagner	- 1916 to 1918 Incl.
P. D. Sergent	- 1914 to 1921 Incl.
J. E. Patterson	- 1914 to 1921 Incl.

Methods by which the data were secured consisted of making annual extensive surveys of the entire area which were supplemented and checked by the results of intensive cruises of a few representative units. These surveys were made during the spring following the year of the annual loss which each survey pertained to.

The accuracy of the data is believed to be very high.

2. Location of Area:

The area is located on the north slopes of the Siskiyou mountains in Jackson County, Oregon. The attacked maps shows the location of the area and its position in the surrounding country.

3. Extent of Area:

The extent of the area approximates 50,000 acres with a stand of 155,800 M.B.M. of yellow pine.

4. Timber Resources Involved:

The character of the timber is medium grade but owing to its accessibility to nearby centers of population is of rather high merchantible value. Some cutting in local stands has been going on for years but it will probably be 10 to 15 years before extensive cutting will greatly deplete the stands. The timber is a mixed stand of yellow pine, Douglas fir, white fir, and a small percentage of sugar pine. The value is probably $3.00 per M. of the pine. The ownership is divided between hundreds of small private owners. No large tracts of single ownership are involved.

5. Cause of Epidemics:

The cause of the epidemic is entirely unknown as no data previous to the inception of the study are available.

6. Cycle of Epidemic:

The following tables and graphs illustrate the cycles of the epidemic from 1914 to 1921 on the entire area and on each of the separate units very clearly:

Table No. 1 - Showing Volume and Percent of Stand Killed Annually by Dendroctonus brevicomis on the Rogue River Area During the Period 1914 to 1921 Inclusive.

Year of Loss	Number of Trees	Total Volume in board feet	Percent of Stand	Percent of Increase or decrease over prec. year: Increase	Decrease
1914	369	346,390	.2		
1915	1,857	1,615,940	1.	366%	
1916	1,630	1,383,480	.9		14.4%
1917	803	608,005	.4		56%
1918	1,187	1,085,315	.7	78%	
1919	780	674,270	.45		37%
1920	609	462,050	.35		31%
1921	383	283,440	.18		38%
Totals	7,618	6,458,890	4.2		

Table No. 2 - Cycle of Dendroctonus brevicomis in yellow pine on the individual units of the Rogue River Area from 1914 to 1920 inclusive.

Unit	Year of	Number Trees	Volume in Board Feet	% of Pine Stand	Percent of increase or decrease over preceding year: Increase	Decrease
Mistletoe	1914	23	34,900	.1		
	1915	130	140,660	.4	303%	
	1916	205	223,440	.6	59%	
	1917	125	87,260	.2		60%
	1918	469	429,650	1.2	392%.	
	1919	244	245,330	.8		43%
	1920	168	129,080	.4		47%
Totals		1,364	1,290,320	3.6		
Lamb's	1914	56	56,190	.4	250%	
	1915	254	208,770	1.4	273%	
	1916	169	108,430	.7		48%
	1917	63	39,010	.2		64%
	1918	82	69,590	.4	79%	
	1919	46	31,550	.2		53%
	1920	18	14,520	.1		54%
Totals		688	528,060	4.1		
Ashland	1914	45	56,250	.2		
	1915	213	226,820	1.	316%	
	1916	379	311,050	1.4	37%	
	1917	146	114,590	.5		63%
	1918	202	199,130	.9	74%	
	1919	46	38,800	.2		80%
	1920	12	12,960	.06		66%
Totals		1,043	659,600	4.36		
Fredrick	1914	16	22,400	.7		
	1915	60	80,800	3.	261%	
	1916	89	87,530	3.	8%	
	1917	68	52,800	2.		37%
	1918	57	46,915	1.7		11%
	1919	44	35,200	1.2		25%
	1920	13	15,730	.6		55%
Totals		347	341,375	12.		

Wagner	1914	50	50,400	.2		
	1915	285	339,840	1.3	574%	
	1916	286	303,890	1.		11%
	1917	130	138,150	.4		60%
	1918	175	212,430	.6	54%	
	1919	142	166,850	.5		21%
	1920	78	84,240	.2		50%
Totals		1,144	1,295,800	3.9		
Coleman	1914	70	77,000	.3		
	1915	345	323,250	1.2	297%	
	1916	164	155,040	.6		52%
	1917	95	93,100	.3		40%
	1918	70	70,000	.2		25%
	1919	78	74,100	.2	6%	
	1920	52	29,640	.1		60%
Totals		894	822,130	2.9		
Griffin	1914	35	35,250	.3		
	1915	230	221,000	2.2	539%	
	1916	176	167,300	1.6		24%
	1917	93	66,490	.6		60%
	1918	52	41,600	.4		37%
	1919	72	57,600	.5	38%	
	1920	40	22,800	.2		60%
Totals		698	610,040	6.1		
Gold Ray	1914	80	16,000	.1		
	1915	340	74,800	.7	367%	
	1916	142	26,800	.3		84%
	1917	83	16,600	.1		38%
	1918	80	16,000	.1		4%
	1919	108	24,840	.2	55%	
	1920	60	24,000	.2		
Totals		893	199,040	2.0		
Total for Area		7,235	6,175,450	4.0		

DATA FOR 1921:

Mistletoe	1921	115	103,500	.3		20%
Lambs	1921	24	20,450	.2	41%	
Ashland	1921	13	11,700	.06		9%
Frederick	1921	5	4,250	.1		73%
Wagner	1921	44	39,600	.1		53%
Coleman	1921	30	18,540	.05		40%
Griffin	1921	42	30,400	.3	33%	
Gold Ray	1921	110	55,000	.5	56%	
Totals for Year		383	283,440	.18		

MR PATTERSON: Previous to 1914, we have no records. At that time the infestation was at a low point. We started in the spring of 1914. The size of the area is approximately 50,000 acres. There is a pine stand on this area of about 156,000,000 feet yellow pine and sugar pine, also in some of the elevations there is white fir and douglas fir lower down. There has been no large cutting operations in this area to the present time. The infestation in 1914 in this area amounted to a total of 346,000 board feet. 1921 is the last year we have any records on the area. We have no evidence to show just what caused the epidemics or just what the factors were that contributed to the decline. The decline was not gradual. The peak of the infestation occurred the second year after the studies were started in 1915. That was followed by a decline to the present time, when the infestation is about what it was in 1914.

MR JAENICKE: Forest officers on the Crater National Forest are becoming thoroughly awake to the pine beetle situation and they are anxious to have the Bureau's opinion as to whether control measures are justified in the Applegate and Rogue River, assuming that the timber is of sufficient commercial value to justify beetle protection.

MR PATTERSON: I understand from reports that the status of the infestation on the Rogue River area and in the Applegate country since 1916 is about the same. I wouldn't recommend control work in the Rogue River area at the present time. Practically all of the timber on the Rogue River area is privately owned with very little State land in it.

History of Epidemics

Southern Oregon - Northern California
Klamath Region.

Introduction:-

Up to the survey of 1921, the information concerning the infestation in the Klamath Lake region is merely hearsay corroborated by the evidence of old loss which was found during 1921. In the fall of 1921 a survey was made by members of the Bureau of Entomology, the Forest Service and the Klamath Forest Protective Association. This survey was made at a total cost of $3300 and represented about a 1% actual cruise of the area and estimates of the rest from general observations. Area 1 was cruised by J. E. Patterson; Area 2 by J. C. Evenden; Area 3 by F. P. Keen; while Mr. A. J. Jaenicke had charge of the work as a whole.

2. Location of Area.

This area is located in Southern Oregon in Jackson, Klamath and Lake Counties, and in Shasta and Modoc Counties of California.

3. Extent of Area.

1,250,000 acres.

4. Most of the area contains a good stand of yellow pine of high value, in all about 11,000,000,000 board feet valued at over 33 million dollars. On account of the extent of the area the character of the stand varies a great deal, also its accessibility. On some parts of the area logging operations are at present being carried on while it will probably be forty years or more before some of the timber is placed on the market.

5. The causes of this epidemic must have been natural factors such as climatic conditions, birds or parasitic enemies, since they can not be laid to artificial ones such as windfalls, logging operations, fire, etc.

6. Cycle of epidemic.

Year	No. Trees	Volume	Percent of Stand	Remarks.
1918	260,000	236,000,000	2.0%)	Probable peak of Epidemic
1919	197,000	177,000,000	1.5%)	Estimated
1920	126,615	115,668,000	.98	Cruise of 1%
1921	102,393	91,961,000	.78	Cruise of 3%
4 yrs.	686,008	620,629,000		

7. The causes for the decline are probably natural ones such as a dominance of the predators through an increase in their food supply.

8. Since this is a very large area conditions are not uniform throughout. The area as a whole did not respond as a unit in the rise and fall of the epidemic, hence the table above represents rather an åverage of what happened throughout rather than what happened in any one part of the area. Thus in some units the loss for 1921 was greater than the loss in any previous year.

In general there seems to have been certain heavy epidemic centers from which the epidemic spread in a widening circle. At the present time the circumference of this circle shows the high epidemic condition and it is here then the greatest part of the control energy is being directed.

Epidemics and their control.

A. History of epidemics past and present.

Causes, cycles and natural control; relation of fire windfalls, logging slash.

2. Rocky Mountain region and southwest. Edmonston, 10 min.

The history of Colorado epidemics, and I must confine myself to D. ponderosae, have clearly demonstrated that trees do not die of old age, neither is there any perceptible rise until after the epidemic has reached considerable proportions and it is a question in my mind if there is then, we are too much inclined to consider the term epidemic as it effects the human race where one case of smallpox or flu may in a short space of time result in thousands of cases and a high death rate.

I do not know of any pine areas of middle age or mature trees where it would not be possible to locate on any section one or more infested trees. What kills the majority of middle aged and mature pine trees, is it not a bark beetle I will say that at the least calculation 95% of all standing dead pine in the Rocky mountain region and southwest has been killed by barkbeetles. I am not taking fire into consideration.

We have had no epidemics in pine except those resulting from D. ponderosae infestation; the pitch stained egg galleries grooving the sapwood can be easily distinguished long after the tree is down and badly decayed, after 40 years you can still find the evidence.

We will say that you have 15 to 35 infested trees in small groups per section comprising a township and this is more or less common, we class this as endemic, should a movement take place bringing together in one or more common centers on a limited area the broods from numerous small centers resulting in a concentration sufficient to infest 1000 trees or more on 200 acres, we class that as an epidemic, are we right? My experience has only been with control of epidemics, I am of the opinion however, and it is based on observations for a good many years, that, if we could cut and treat even 50% of the D. ponderosae infested trees under so called endemic conditions we would break up the broods to the extent that it would weaken their forces and prevent any heavy concentrations which we class as epidemics, and of which we have a number of examples both past and present.

The term <u>cycle</u> is hardly applicable to D. ponderosae infestations, 50 years or more may pass before customary endemic infestation arrives at a point where it can be classed as epidemic. Any increase is so gradual and covers such a long period of years that when it does reach large proportions we assume that it must be the result of a sudden increase. I have never been connected with

an epidemic control project that I did not feel I would like to have arrived on the ground at least three years earlier, and in some cases eight years would not have been any too soon, which all goes to show that if we depend upon cycles we will in most cases view a considerable deadening before the cycle starts in on its downward course.

I know of no D. ponderosae epidemics that could be traced to fire, windfalls, logging or slash.

On the Kaibab National Forest, Arizona, only a few small fires have been recorded during the past 30 years. Burns of very old origin 75 to 150 years are plainly in evidence but these are much too old to be connected with the present heavy infestation, much of which originated in the stand that has replaced or escaped early fires. Windfalls are the exception and not the rule, wind thrown pine did not show the work of the primary beetle.

As not more than half a million feet all told has been logged on this forest we cannot consider that, as having a bearing on the present infestation, furthermore the cuttings are far removed from present infested areas.

It is 13 miles on an air line from the north to the south rim of the Grand Canyon. The Kaibab plateau extends from the north rim north for 50 miles, the timbered width about 30 miles, it is entirely surrounded by so-called desert. On this north side we have a virgin forest where the disturbing factor of man's presence and work is a mere scratching of the surface in spots when compared with the "Coconino" National Forest on the south, here we have the same type of forest and much the same altitude, quite as much if not more pine of the same ages and class.

On the Virgin forest "Kaibab" we have heavy D. ponderosae infestation centered on about one fifth of the timbered area. From evidence on the ground and a record of reported infestation on this forest made by Forest Inspector Benedict in 1908, we can be sure that it existed at least 14 years ago and has not decreased during that time, but has gradually increased.

I will now read my report on the Coconino National Forest.

REPORT ON INSECT INFESTATION

IN THE COCONINO NATIONAL FOREST, ARIZONA.

By
W. D. Edmonston.

Examinations in this forest covered the period from August 15 to 19 inclusive. Forest Supervisor E. G. Miller planned the various trips which were made by Forest Service automobile.

We were fortunate in having Mr. Miller take Mr. Hofer and I over the forest as he was thoroughly familiar with the ground as well as the various timber sales both old and new, logged over areas and burns. Ranger C. L. Lincoln accompanied us on two trips and Deputy Supervisor M. L. Nichols on two Mr. Miller being desirous that they should receive instructions in the identification of the work of the primary and secondary insects and the more important features relating to insect damage in general which we were specially glad to have the opportunity to do.

Timber Sale Areas

All the important timber sale areas west and southeast of Flagstaff were studied and fairly well covered in detail to form conclusions of present conditions. Sale areas examined are as follows: Arizona Lumber and Timber Co. Sale; Flagstaff Lumber Co. Sale; McGonigle Lumber and Development Co. Sale; Greenlaw Lumber Co. Sale. Most of these sale areas are centered in an excellent stand of middle aged and old mature yellow pine; reproduction is in most cases well assured, in fact is quite dense on most of the areas examined.

The actual milling operations are carried on at various points on the Santa Fe Railroad at Flagstaff and east and west thereof. The logs are transported to the mills over specially constructed branch roads from the main line. After the logs have passed through these mills what little refuse remains is burned.

The logging operations as carried on now in this forest show excellent forest management. The result is there is no insect infestation of a serious nature; in fact the cuttings have solved the problem in this forest. As long as it continues there will be no danger of any outbreaks by either the Black Hills Beetle (Dendroctonus ponderosae Hopk.) or the other Dendroctonus such as barberi, convexifrons or approximatus. The timber sales are so planned that the overmature ripe or old pine timber is being cut, leaving the thrifty young and most of the middle aged trees for a future crop 20 to 30 years hence or longer as the case may be.

There is no doubt in our minds that the logging of the mature timber and the continued cutting, especially the latter, result in a natural control of,

the destructive insects. This can be seen on all the cuttings, and areas adjacent or within a radius of three miles are comparatively free from infestation. The fresh cutting has a strong attraction and the insects drawn from a considerable distance eventually reach the mills where they are destroyed when the logs are converted into lumber.

Areas far removed from the sale areas mentioned show the usual sporadic or endemic type of infestation and more of the work of D. ponderosae. This most likely will be taken care of as the logging operations are being pushed rapidly in the direction of the heavy stands of old ripe timber. The Flagstaff Lumber Co. is now cutting in the vicinity of Mormon Mt. over 20 sectional miles southeast of Flagstaff.

Brush Disposal in Relation to Insect Infestation

We have given this matter of brush disposal a deal of thought and we expect to continue to do so whenever the opportunity presents itself as it did in this forest. No Dendroctonus were found in any brush or slash on any of the sale areas. Secondary insects were common but not abnormally so considering the ample food supply; Ips, Pityopthorus, Cerambycids and Buprestids were mostly in evidence. The red turpentine beetle (Dendroctonus valens) was common in freshly cut stumps: it is following right along with the cutting just as the others are doing.

At the present time the secondary insects are of great value as they hasten the decay and more rapid disintegration of the brush, especially Ips: These insects which as adults bore through the bark and raise a brood between the bark and the sapwood admit other agencies which result in still further decay. The secondary insects in this case seem to be doing more good than harm; the small amount of damage they might be capable of is well offset by the good they do which will continue for many years and quite as long as the present system of cutting is continued.

The disposal of brush by burning, unless as a fire prevention measure, is unnecessary and may do more harm than good unless it could follow the cutting within a few weeks; in most cases it does not except in the winter months. Nearly all the secondary insects that are found infesting the brush or slash raise a brood every 4 to 60 days during the summer months, or from May to October, and in this way keep close up with the cutting and months ahead of the brush burning. Round ~~tx~~ and flatheaded borers are ~~ta~~ entirely secondary in pine slash and these and some very important predatory insects are all that late brush burning would destroy. Areas logged three to four years ago show no injurious effects either from brush left on the areas or from the thinning of the stand.

Old Logged-over Lands.

The Greenlaw cutting northeast of the Elden Mts. north and east of Flagstaff was examined. This cutting was carried on over a long period of years during which time most of the merchantable timber has been logged. We could

find nothing in the way of insect infestation on these areas or on adjacent tracts that would indicate any damage had resulted. The few scattering dying trees observed were those that had suffered some injury. D. barberi and approximatus were the infesting insects and were having a hard struggle in overcoming the trees; the attacks showed the work of two years, the top and portions of the main trunk being killed one year and the second year completed the girdling or it was in process of being completed. We could find no evidence of any bad results from anything that might have bred in the slash. This same condition prevailed on an old McGonigle cutting about eight miles northwest by west of Flagstaff. Only a few mature trees per section were found to be dying. Wherever it is possible to do so this class of stuff is disposed of in small cord wood sales or by free use.

Recent Burns.

Some of the old burns and those of 1920 were examined. The losses from insects in the fire scorched timber has been very slight. Only one burn showed real damage by insects since the fire and only trees that had suffered severely and had badly charred butts. The attacking insects were D. approximatus infesting strips on the main trunk on the side least affected by fire; Ips on the heavily charred sides; the fresh egg scars of Monochamus and Acanthocinus species were common on all portions of the main trunk indicating a decided weakened condition of the scorched trees; D. ponderosae was not in evidence.

Two of the burns are close to fresh cuttings which attraction should offset any that the badly burned trees would have. These burns have been subject to three seasons of infestation yet the actual loss from insect attack is very slight and the attacking insects, outside of partial attacks by D. approximatus, are entirely secondary and could not under any circumstances overcome a thrifty or ~~u~~ninjured tree. In any case there is nothing to show that they have done so; our judgment is based on actual conditions as we find them on this forest from past and present evidence as recorded in the infested trees-new and old, standing and down.

The Virgin Forest

From a steel lookout tower on Mehan Mt., 40 miles southeast of Flagstaff, an excellent view of the surrounding timbered region was obtained. There is no epidemic infestation of any mature whatsoever and one could view the country for at least 15 miles in all directions. An occasional sorrel or redtop tree was noted, almost every section had a few, we would judge not over eight to twelve trees per section, none in clumps, more on the crests and points of ridges than elsewhere. Judging from examinations on our return trip the following day, via Long Park and Munds Park, heavily timbered region, the red and sorrel top trees are those which in most cases have been ~~xx~~ injured by lightning and later attacked and killed by the combined attack of D. barberi, D. convexifrons and D. approximatus; some D. ponderosae work was in these and other trees.

Conclusions.

As the logging operations have covered a considerable territory and have left no bad effects in their wake, and as they are now approaching along lines that will soon carry them into the heart of the heavily timbered areas 25 to 40 miles southwest, southeast and south of Flagstaff, it would seem unnecessary to suggest any direct insect control work for the purpose of reducing endemic infestation where the areas within a short period of time will be subject to extensive logging operations.

The loss from insects, more or less induced and encouraged by lightning-struck trees, is quite heavy as the large overmature trees are those that are being killed and by no means always those struck by lightning. If the timber in Long Park and vicinity could be logged now, it would seem to us the best method as it would insure the removal of the old rapidly deteriorating timber most liable to lightning stroke and attack by insects. In this region endemic insect infestation shows a considerable increase over former years, 15 to 20 years or more. Logging operations are much too far removed at present from this area to have any effect in the way of attraction, at least it shows a higher percentage of loss than do areas in the vicinity of cuttings. It is very doubtful if it would pay to treat the infested trees where there is the possibility of disposing of the mature timber within a reasonable time.

There is no evidence of damage by secondary insects and the burning of brush, tops, etc., as a means of control is not necessary.

The present excellent methods of forest management will eventually in this forest greatly reduce the hazard from epidemic infestations as well as reducing endemic annual losses from insects.

Sabino Canyon, Tucson, Arizona.

CHAIRMAN: I might say, Mr. Edmonston, that Mr. Pierce of the District Two, Forest Examiner, has data approximately the same as yours. He states that in the yellow pine stands of Colorado, on the Durango National Forest, where the stand is three hundred years old, that in the life of a stand of timber, 90 per-cent is killed by insects and 10 per cent by windfalls, and diseases, and other causes. And in three hundred years the entire stand will be replaced. Your data was 95%, was it not?

MR EDMONSTON: No, what I meant was that the actual responsibility for the killing of the tree rests with the D. ponderosae. and 95% of the killing of standing dead trees could be traced to them. That left 5% for mistletoe, fungus, lightning, dry weather, wet weather, the moon, and all that. I eliminated fire.

MR PATTERSON: Did I understand Mr. Edmonston to say that these beetles spread about three miles from the logging operations?

MR EDMONSTON: I stated that the effect of the logging operations were noticeable for three miles, as soon as you got beyond that then you find heavy endemics.

DENDROCTONUS MONTICOLAE INFESTATION

IN THE WHITE PINE STANDS OF NORTHERN IDAHO.

(By J. E. Evenden)

INTRODUCTION

From observations in thé white pine belt of northern Idaho it is believed that depredations by Dendroctonus monticolae existed for many years prior to the creation of the National Forests. Evidence of old epidemics which occurred many years ago can be found throughout the entire stand. The first report of this infestation was made in 1909 by the Supervisor of the Coeur d' Alene National Forest, who stated that the losses in the past ten years from insect attack were 100,000,000 b.f. Subsequent reports were made by Forest Officers until 1915. In the past seven years the writer has kept in direct touch with the situation, and it is believed that the data submitted by Forest Officers prior to 1915 is fairly accurate.

Location of Area.

Infestation is located throughout the ~~mm~~ white pine belt of northern Idaho in the Coeur d'Alene Mountains.

EXTENT OF AREA.

965,000 acres of white pine type.

TIMBER RESOURCES INVOLVED.

Area supports a stand of 19,305,000,000 b.f. of white pine (Pinus monticola) which is all merchantable and of a high commercial value. A large volume is being cut each year and practically the entire stand is accessible.

Ownerships:

Federal government	23	percent
State "	13	"
Privately owned	64	"

CAUSES OF EPIDEMIC

No data is available relative to the cause of the infestation, which

has at various times increased into serious epidemics. In 1912-13 following the 1910 fires there was a severe epidemic, and the theory advanced by many Forest officers was that the fires were responsible for the increase as weakened host material was provided for them to attack.

CYCLE OF EPIDEMIC

As no surveys have been made of this infestation it is impossible to present positive figures on the volume of timber killed. Estimates have been made which are believed to be very conservative:

1900 - 1910

Volume killed	1,930,500,000 b.f.
Trees killed	2,750,000
Percent of total volume	10%

1911- 1920

Volume killed	1,158,000,000 b.f.
Trees killed	1,650,000
Percent of total volume	6%

DECLINE OF EPIDEMIC

As stated in a previous paper the decline of the epidemic to a normal status, and the fact that it has remained at that status, to the extensive logging operations which have been carried on throughout the northern part of Idaho. In 1914 a small amount of control operations were carried on by the Forest Service in the Coeur d'Alene National Forest, but this could not have influenced the entire white pine belt.

BLACKFOOT RIVER VALLEY INFESTATION.

MONTANA

(By J. C. Evenden)

Introduction

This infestation was first reported by Mr. Joseph Brunner, Bureau of Entomology, in 1913. At that time there was but a small number of trees (lodgepole pine) infested at Lake Inez, Clearwater drainage, Blackfoot River Valle. Subsequent reports were made by Mr. Brunner, from time to time until 1917. Field examinations were made by the writer during the winter of 1914-15, May 1921, and June 1922. Mr. Rust, Entomological Ranger assigned to this station, made an examination of the present location of this infestation in the Helena National Forest in October, 1922. All data secured has been from extensive examinations, but is believed to be fairly accurate.

Location of Area.

Flathead, Missoula, and Helena National Forests, Montana. Privately owned land, and public domain. From the starting point of this epidemic it has spread into the Flathead National Forest, and up the Blackfoot River into the Helena National Forest.

Extent of Area

Since this infestation was reported in 1913 it has covered approximately the following acreage:

Total acreage	1,600,000
Timber acreage	700,000

Timber Resources Involved

In the Missoula and Flathead National Forests the timber attacked was lodgepole pine and yellow pine. As there is but very little yellow pine in the Helena National Forest the losses have been limited, so far, to lodgepole pine. The timber over the entire area is mature and merchantable, especially the yellow pine.

In the Missoula National Forest, or rather in the drainage of the Blackfoot River, a large volume of yellow pine has already been marketed. The yellow pine is of high commercial value as it is the principal timber species of Montana. The lodgepole will not be in demand for many years.

CAUSES OF EPIDEMIC

This infestation could have originated from an increase of a normal infestation at Lake Inez, where it was first reported, or it could have crossed into the Missoula National Forest from the Flathead National Forest, where an infestation had been previously reported. However, it appears that this infestation started on the Clearwater drainage of the Blackfoot River and spread both north and south. No reason or cause can be given for this epidemic.

CYCLE OF EPIDEMIC

This infestation started in lodgepole pine in 1913. The following year losses were recorded in the yellow pine stands adjacent to, and intermingled with, the lodgepole infestation, which were epidemic in form until 1917. At that time there was a rapid decrease in the yellow pine infestation and it has remained at a normal status until 1922, when a marked increase of annual loss was recorded at Lincoln, Montana.

Though the epidemic in yellow pine died down, there was no corresponding reduction of the lodgepole losses. This infestation has remained in an epidemic form, with perhaps slight fluctuations which were hardly noticeable. In many regions there has been a marked reduction of the epidemic, but these are generally brought about by the lack of suitable host material.

Since the start of this infestation the number of trees killed, volume, and the percent of the total volume and given which are estimates only, but checked by Forest Officers and private timber owners.

	Lodgepole pine	Yellow pine
Tree killed	60,000,000	182,000
Volume killed	600,000,000 b.f.	127,800,000 b.f.
Percent of stand	25%	18%

DECLINE OF EPIDEMIC

There is no data relative to the decline of the infestation in yellow pine. In 1917 Mr. Brunner and Forest Officers, reported that the infestation was being checked by natural agencies. This may have been responsible for the reduction of the yellow pine losses, but those in lodgepole pine have not been seriously reduced since the start of the epidemic.

RELATION OF LOGGING TO FOREST INSECT EPIDEMICS.
By
J. C. Evenden.

The knowledge of the existence of the relationship between logging operations and insect epidemics is not new for I quote from Bulletin 83, Part I. U. S. Department of Agriculture, by Dr. A. D. Hopkins which was published in 1909, as follows: "The cutting of living timber for commercial purposes may offer favorable conditions for the multiplication of some of the species, like the Douglas fir beetle and western pine beetle, but if the cutting, within a range of 50 square miles, is more or less continuous, it appears to serve as a protection to the living timber rather than otherwise. On the other hand, local sporadic cuttings may bring about more or less serious results." Later in 1918, Dr. J. M. Swaine, Canadian Department of Agriculture, devoted a section of his bulletin "Canadian Bark Beetles" to the possible influence of the refuse from logging operations upon bark beetle epidemics. This belief, that a continuous operation tends to protect the adjacent timber stands, which was first advanced by Dr. A. D. Hopkins in 1909, coincides with my observations in Idaho.

In 1907 Forest Officers reported serious losses in the white pine stands of Idaho from the attacks of Dendroctonus monticolae. These losses varied from light attacks to 40 - 50 percent of certain stands.

In 1909 the Supervisor of the Coeur d'Alene National Forest reported that a conservative estimate of the losses from insect attack on that forest during the past ten years was 100,000,000 b.f. The efidence of this epidemic are still to be seen throughout the forest, as well as the entire white pine belt. Prior to 1919 but very little white pine had been logged on this forest. Following the 1910 fires logging started in this forest on a very extensive scale. Following the inauguration of these operations, which were scattered fairly well over the entire forest, the infestation apparently decreased very rapidly. In 1913 the infestation, as reported by Forest Officers, was centered in three small drainages of the Coeur d'Alene River, which were remote from any cutting operation. In 1914 control work was conducted by the Forest Service in these areas which were some 40 miles apart, and an attempt was made to treat 100 percent of the infested trees. In 1915 I examined these areas and found that there had been a reduction of the infestation in all of them which varied from 80 to 90 percent. Throughout the entire forest, though there was plenty of evidence of previous losses, the infestation showed a decided reduction during the past two or three years, and was in approximately the same status as the areas where control measures had been applied. Though the control measures were no doubt responsible for the cessation of the epidemic in the areas treated, it could have had no effect upon the entire forest. It is believed that the logging operations scattered throughout the forest were responsible for the general decline of the infestation, or at least for its maintenance at a normal status. The reason given for this, is the method of logging which was, and is still

generally followed, in this region. Logs were cut during the summer months taken from the higher elevations to the river by chutes, and there decked. In the woods these logs were left from one to several weeks before being run down the chutes to the eiver. An examination of these logs in the woods during July would show a large number of them freshly attacked by Dendroctonus monticolae. In the early spring before insect activity starts, at the time of the first high water, these decks are broken and the logs driven down the Coeur d'Alene River to the Lake. To summarize, the beetles are attracted to these logs and later destroyed by the submersion of the logs in water. Another reason for the reduction of this infestation by continuous logging operations is that advanced by Dr. Hopkins which is as follows: " Practically all the evidence we have, including many years of my own observations, indicates that such operations, (continuous) tend to prevent outbreaks, because the insects breeding in the slash will return to other slash as soon as it is available and in time they will become so adapted to such breeding places that they will not go into the living timber."

Since 1919 the logging of white pine has been very extensive and the general condition of the infestation throughout the entire white pine belt remains at a normal status. There are local exceptions to this condition in areas which are separated from cuttings, either by distance or semi-barriers, where serious losses are incurred every year. The timber of a drainage of the Coeur d'Alene National Forest, was recently sold at a stumpage proce of $12.50 per thousand board feet. This drainage contained a stand of 23,000,000 b.f. of white pine, of which 5,000,000 b.f. valued at the present stumpage price at $12,500, had been killed by insects (Dendroctonus monticolae) in the past ten years. All areas of white pine similar to this, which are remote from cuttings are suffering a heavy annual loss due to the ravages of the mountain pine beetle.

From a study of the history of past epidmics in Idaho and Montana, and from personal observations it is believed that one would be reasonably safe in assuming that in areas where there is a continuous cutting operation that there will be very little danger of serious losses in adjacent timber stands from forest insects. This fact is especially true in white pine stands, but definite information upon its effects upon infestations in yellow pine is not available. Though the possible benefits to be derived from a continuous cutting are recognized, the danger to the surrounding timber stands from the slash from sporadic cutting is as easily seen. By the term slash is meant all that refuse which is left in the woods following logging which includes tops, chunks, cull logs, butts, etc. Should it so happen that logs are cut and left in the woods over a period of such length as to provide a breeding place for destructive insects, then from a viewpoint of protecting the adjacent timber stands these logs would be included with the other refuse as slash. Though a great deal of information is available on this subject I shall cite an infestation which is believed gives the clearest data.

At Arling, Idaho, Payette River Valley, there is a small saw mill, with a possible capacity of 12 - 18,000 b.f. per day, which has been operated by a farmer since 1908. This mill was usually run in the fall of the year, after the harvest season, on the plan of logging one day and sawing the next. In 1918 the output of this mill was increased by lengthing the running time. Logs were cut in the spring, during a slack time on the farm, and left in the woods during the summer for a continuous sawing in the fall. Following the start of this practice on the epidemic of the western pine beetle started in the yellow pine stands adjacent to this mill, which has caused a loss of fully 15 percent of a stand of over 10,000,000 b.f. This infestation was examined in May 1922, and all the evidence secured pointed towards the fact that the beetles had been attracted to the freshly cut logs for the summer generation, and upon emergence in September had gone into the standing timber due to the lack of further slash, and that this had continued for season after season. An examination of all chunks, cull logs, butts, and large tops left in the woods during the summer of 1921 showed that in every instance this material had been heavily attacked by the western pine beetle. However, the over-wintering generation was to be found in the standing timber near by. This theory was further substantiated by a later examination of this area in September 1922. At the time of the May examination the owner of this mill was cutting logs which were left in the woods until this fall. Every log examined in September showed a heavy attack from the overwintering broods, which must have come from the standing timber adjacent. These beetles had nearly all emerged at that time and as there was no freshly cut slash for them to attack it was assumed that they would go back into the standing timber. Several freshly attacked trees were recorded in the adjacent area, but no records of the 1922 summer generation what ever.

Though it is realized that the evidence as presented can not be taken as conclusive proof, it is hoped that sufficient data can soon be secured which will establish the importance of logging slash toward the starting of Dendroctonus infestations in adjacent timber stands. Should it be decided that such refuse is a menace to the adjacent timber stands, as related to the starting of insect infestations, then a great deal can be done towards the prevention of such epidemics by the adoption of cutting and administrative regulations.

In closing it seems well to mention a point brought out in this paper, which might well be questioned, if statements in a previous paper is considered. It has been mentioned here that the mountain pine beetle is attracted to freshly cut logs, and later destroyed by the logs being driven down the Coeur d'Alene River. And it is here that the question could be asked that if this is a fact, why can not trap trees be used in control operations. The only answer that can be given for this is the fact that there is little similarity between a few trees cut for traps and scattered throughout a stand, and a logging operation where from 75 to 90 percent of the volume is cut. And quite often in spite of the large quantity of freshly cut material available, seed trees, left for reproduction purposes, are often attacked.

MR EDMONSTON: You mean the epidemics were crossing the divide. Is it a lodgepole stand across over the divide, there is no barrier of bare ground above timber line is there?

MR EVENDEN: As to that I cannot say. A lot of this data is forest service records by sections. Just what the conditions of the extreme elevations of the continental divide are I am not sure. I am inclined to think there is a bare stretch of territory there.

MR EDMONSTON: Couldn't it have originated then on the other side of the mountain and not necessarily cross over?

MR EVENDEN: I think that it is entirely possible. It might be of interest to you to know that the A. C. M. Lumber Company cruised their holdings within this area in 1902 and again in 1922, and the results of these two cruises show a loss of 25 percent. As the same man made the two cruises the company has accepted this figure without question. Our records show us that this loss occurred after 1912.

MR EDMONSTON: Now suppose that it would be possible to get action on the beginning of one of these infestations. There must be a beginning, it can't spread suddenly over a whole township. Do you think there is any possible way to get action on it before it arrives at the epidemic.

CHAIRMAN: That is exactly what I am trying to do. I think there are about five hundred trees infested there now. Better to spend even $5,000 on those five hundred trees; if an epidemic can be prevented. From an economic standpoint the timber is hardly worth a very great expenditure unless an epidemic is prevented. I feel that this will be an experiment which is worth attempting as we do not know what we can do. However, we all realize, I believe the impracticability of attempting control of one of these severe lodgepole infestations.

MR JAENICKE: Is there any evidence to indicate that there will be any change in the status of the infestation when logging operations cease?

MR EVENDEN: Depends a great deal upon when the logging operations stop.

MR PATTERSON: Whether or not it does depend upon logging operation rest on if the beetles bred in the traps.

BURKE: Has an epidemic started from a cessation of logging operation.

EVENDEN: Believe in one case of an epidemic started.

BURKE: Cites several cases where insect epidemic was stopped by logging.

EDMONSTON: Most successful control in Colorado was by logging operation.

MR EVENDEN: Feels that the main thing is in the "clean up."

MR JAENICKE: It is important that those interested in timber protection thoroughly understand our position on the effect of logging on beetle infestations. Undue emphasis on our part in regard to the importance of logging to control epidemics may easily result in the encouragement of the immediate cutting of green timber which shouls be held for later logging in order to assure permanent forest production.

By conducting logging operations in an infested region and in yellow pine or in white pine, the beetles are drawn to the green logs. These logs are taken to the mill before the emergence of the beetles from the logs. By the destruction of the slabs at the mill, the beetles are, of course destroyed also. In this way, logging results in a decrease in the number of tree-destroying beetles in the region of the logging operation. However, it seems to me that the big question which needs to be settled by further study is "From how much standing timber do logging operations draw the beetles." In other words, we need to know the entomological sphere of influence of a logging operation.

Again and again it has been suggested that it would be practicable to carry on portable saw mill operations in connection with the control of brevicomis infestations in yellow pine. That is, it ought to be possible to cut down the infested trees and saw them up at a profit and thus save the control costs now involved in stopping epidemic infestations. The usual impracticability of such a plan is due to several conditions. In the first place, but rarely will brevicomis infestations yield more than one hundred trees per section or more than one tree to every six acres, ordinarily, fewer trees than this would be secured. In the second place, even before the beetles emerge, the sap is badly blue-stained. Further much of the cutting would have to be done at a time of the year when logging is very difficult and in places where an adequate water supply for even a small mill is absent. To augment the scattered supply of infested timber by using the Beetle-abandoned timber is out of the question as a recent study of the Bureau of Plant Industry has convincingly proven. This study showed that beetle-abandoned timber has sapwood that is practically worth less because of fungus activity and because of season checks. There are other considerations which make logging of infested yellow pine on the Pacific Slope instead of the regular treating proceedure, impracticable.

MR EVENDEN: How much do you consider? In one or two instances, timber has been put up for sale on account of infestations.

MR MILLER: Where logging is feasible as in the case of the Payette, we might as well assume that the method will improve conditions. If it does not we will soon hear of it. The method is being tested to some extent on the San Joaquin area.

MR EVENDEN: If we can control by peeling or submerging why can't you cut down the infestation by logging.

MR KEEN: Each case is different. In going into a large yellow pine area where infestation is scattering it would be impossible.

MR EDMONSTON: States the Forest Service method of carrying out the logging operation on the Coconino, very effective.

PINE SLASH AS RELATED TO
DENDROCTONUS INFESTATIONS.

A STUDY OF THE GREENSPRING HIGHWAY ROAD SLASH
SOUTHERN OREGON.

By
J. E. Patterson.

INTRODUCTION

A study of the character and extent of damage to adjacent standing timber caused by *Dendroctonus* beetles breeding in road slash was undertaken by the Ashland Station in the spring of 1920. The purpose of this project was to determine if pine timber slashings constitute a menace to surrounding pine timber and to secure entomological data relative to such slashings.

The problems investigated related to:

1. Concentration in the slash of normal infestation of *Dendroctonus* beetles from standing pine timber adjacent to and surrounding the slashed trees.

2. Increase or decrease in the general infestation caused by broods developing in the non-resistant slashed trees.

3. The relative annual loss in adjacent standing timber caused by beetles developing in the slash.

4. The efficacy of trap trees in drawing infestation from standing timber, and the rate of dispersion in the surrounding forest consequent on this condition. To determine the preference, if any, that *Dendroctonus* beetles show toward slashed trees over standing trees.

5. Entomological data relative to brood mortality in slashed trees.

The following information on these subjects is based on data secured during the years 1918 to 1922 inclusive by J. E. Patterson and F. D. Sergent:

These data are considered fairly accurate and are believed to be a reliable basis for the conclusions drawn.

The method used in securing the data on the annual infestations of the general area involved in the study is the same as that used in making extensive insect surveys in western forests. It consists of a topographic viewing by the observer and of spotting all insect killed trees which are located on a field map of the area under study. A few representative sections, which have already been spotted, are then carefully cruised by running paralell strips across them. All insect killed trees are examined and tabulated in the form of annual losses. A comparison of the number of trees previously spotted with the number actually found on the area or sections intensively cruised supplies a factor which is applicable to the entire area under study. The total annual infestations on the area is then arrived at by multiplying the trees spotted during the topographic viewing by this factor.

The data on the annual losses in the intensive zones paralelling the slash were secured by intensively cruising these zones; that on the infestation and subsequent emergence of the slashed trees by an examination of each tree.

The data on brood mortality in slashed trees and percentage of normal emergence from them were obtained in the following manner:

<u>Trees attacked by Dendroctonus brevicomis</u>: The exit holes in one square foot of bark from each infested tree were counted and the total number tabulated under the serial number of the tree. It has been determined through experiments that each <u>brevicomis</u> adult excavates its own emergence hole and every exit hole in the outer surface of bark represents the emergence of one adult beetle. It has further been determined that the average normal emergence is 80 beetles per square foot of bark surface and this is represented after emergence by 80 exit holes in the outer surface of the bark.

Using these figures as a basis it was possible by the above method to ascertain the percentage of emergence as compared to normal and consequently to determine the approximate brood mortality which occurred in each slashed tree.

<u>Trees attacked by Dendroctonus monticolae</u>: One square foot of bark was taken from each infested tree and subjected to examination similar to that used in the case of <u>brecivomis</u>. However, owing to the disimilar habits of <u>monticolae</u>, it was not possible to determine the actual number of beetles emerged by counting the exit holes as one or more adults of this species may emerge through one exit hole. Therefore a modified method was used, which was as follows:

The pupal cells, which are apparent on the inner surface of the bark, were examined and counted. Each abandoned pupal cell not showing a dead larvae, pupae or new adult, or parts of any of these forms, was taken as evidence that the adult of this cell had emerged. The emergence then was based on the number of clean pupal cells per square foot of bark.

It has previously been determined by analysis of a number of records on this species that the average normal brood puts out about 60 adult beetles per square foot of bark surface in sugar pine and a trifle less number in yellow pine. 60 emerged beetles was taken as the basis in these studies. It was also determined that the average number of new adults which emerged from one exit hole is 4. It is admitted that the above statistics on monticolae are not as reliable or conclusive as those on brevicomis.

2. Location of Area and Timber Types:

The area involved is located in southern Oregon, in the timbered region between Ashland and Klamath Falls. It is shown on the accompanying map. The area is more or less heavily timbered with primitive stands of yellow pine and sugar pine in the lower and mean elevations. In the higher elevations these species are replaced by white fir. Approximately 10% of the pine stand is composed of sugar pine. The range in elevations is between 3,000 and 6,000 feet.

3. Slashing of the Right-of-way:

The highway passes east and west through the approximate center of the general area selected as offering the best topographic and type barriers considered sufficient to greatly isolate the infestation units from outside influence.

The preliminary work in the construction of the road consisted of falling the trees on the right-of-way. The selected route was slashed to a width of 100 feet. The felled trees were trimmed and bucked to either side of the slash. The elevations of the slash range from 3,400 to 4,800 feet.

Three main divisions of the road were made by the State Highway Commission and each division or sector was slashed and graded before work was started on the next sector. As this program had a direct bearing on the investigations and results of the study, mention must be made of it here.

Sector 1, (from the Greenspring mountain to Jenny Creek, a distance of 10 miles) was slashed during the period August 20, 1919 to May 30, 1920.)

Sector 2, (From Jenny Creek to Hayden Creek, a distance of of 15miles) was slashed during the period October 15, 1921 to July 1922.

Sector 3, (from Hayden Creek to Keno, a distance of 12 miles) is now under construction. The slashing in this sector was started in November 1922.

Only the first two sectors have been given attention so far as it is at this time too early to work sector 3.

At the present time the data relative to results of emergence from the slashed trees are available only for Sector 1 only. The entomological data on slashed trees can be given for sector 2. All other data herewith given applies to Sector 1 and its surrounding area.

4. Infestation on Area Preceding Slash: Sector 1 :

The infestations on the area west of Jenny Creek (see map) for the two years 1918 and 1919, preceding slash, which was determined by extensive surveys, is shown in table 1, and amounted to a total of 693 trees with a volume of 589,000 b.f. in 1918, and 781 trees with a volume of 702,000 b.f. in 1919. Thus it will be seen that the infestation preceding slash was nearly balanced or static.

Table I. Infestation on Area Preceding Slash.

Year	Number of trees	Volume
1918	693	589,000
1919	781	702,000

As one of the primary purposes of the study was to determine the amount of infestation concentrated in stands adjacent to the slash and the relative annual loss in these stands, it was necessary to make intensive surveys of the adjacent timber on both sides of the highway slash. Strips one mile wide on both sides of the slash were mapped and have been given intensive annual surveys to determine the condition in these intensive zones. As before stated the conditions in the general area outside these intensive zones have been determined by extensive survey work.

The infestation of 1918 preceding slash and of 1919, during the period of the first slash work, in the intensive zones, which also indludes the slash, is shown in Table II. and amounted to 236 trees with a volume of 281,000 b.f. in 1918 and 437 trees with a volume of 372,000 b.f. in 1919.

Table II. Infestation in Intensive Zones Preceding Slash.

Year	Number of trees	Volume
1918	236	281,000
1919	437	372,000

5. Number of Pine Trees Slashed and Number Attacked:

Table III. gives the number and volume of pine trees slashed and the number and volume attacked in Sector I.

TABLE III. - Comparative Figures of Trees Slashed and Trees Attacked: Sec. I.

Designation	Totals		Percemtage	
	No. Trees	Volume	No. Trees	Volume
Trees Slashed	452	602,700	100%	100%
Trees Attacked	436	590,050	96.5%	97.9%
Trees Not Attacked	16	12,650	3.5%	2.1%
Yellow Pine	433	533,500	95.8%	88.5%
Yellow Pine Attacked	417	520,850	96. %	97.6%
Sugar Pine	19	69,200	4.2%	11.5%
Sugar Pine Attacked	19	69,200	100%	100%

Table IV. shows the number and volume of trees slashed and trees attacked in Sector 2.

Table IV. - Comparative Figures of Trees Slashed and Trees Attacked: Sec. 2.

Designation	Totals		Percentage	
	No. Trees	Volume	No. Trees	Volume
Trees Slashed	685	1,213,440	100%	100%
Trees Attacked	685	1,213,440	100%	100%
Yellow Pine	559	884,450	81.6%	73%
Sugar Pine	126	328,990	17.4%	27%

The yellow pine trees were attacked by Dendroctonus brevicomis. The broods of this species in the slashed trees were usually associated with Dendroctonus monticolae and Ips sps. However, brevicomis was considered the primary insect. The sugar pine trees were attacked by Dendroctonus monticolae either alone or occassionally associated with Ips. sps. but these latter were always secondary.

6. Development of Broods in Slashed Trees: Mortality:

One significant result of the study was the poor development of broods of both primary insects and consequent high relative mortality in the slashed trees. This result is graphically illustrated in Charts I. and 2. Chart 1. shows the number and volume of trees slashed in each Road Station and the period the trees were felled. It also shows the comparative and corresponding percentage of normal emergence from these trees. Chart 2 is a summary of these data with the yearly average percentage of normal emergence for the various periods when the slash accumulated. The difference between the percentage of emergence and normal broods (indicated as 100%) is the percent of brood mortality which occurred in the slashed trees. An anlalysis of these charts indicates that a relative high mortality occurred in all slashed trees regardless of the annual period they were felled.

The lowest brood mortalitty occurred in trees which were felled in May and June and the highest occurred in trees which were felled in September and October. No satisfactory reasons were found to account for these results. The lower mortality can probably be accounted for by the fact that the trees felled in May and June were attacked immediately after they were slashed and while conditions in the trees were still normal and favorable to barkbeetle development. Also owing to the season the broods in these trees would develop and emerge sooner, than the broods in trees felled during any of the other periods.

It is shown by the yearly average that the emergence of Dendroctonus brevicomis was only 26% of normal and of Dendroctonus monticolae 38% of normal. Therefore the average relative mortality in D. brevicomis was 74% and D. monticolae 62%.

7. Character and Amount of Dendroctonus Infestation Developed after Emergence from Slash and Standing Trees Adjacent to Highway.

Data on this head has been made available for the area surrounding Road Sector 1 only. It is yet too early to secure these data for the area surrounding Sector 2. The following data were obtained by making annual intensive surveys of the Intensive zones paralelling the slash and by covering the surrounding general area by the extensiwe survey method. Tables I. and II. show the amount of annual infestations in the intensive zones and surrounding area for the two years immediately preceding slash. The following table shows the annual infestations in these areas for the period 1918 to 1921 inclusive. Therefore at this date we have complete figures on these infestations for two years preceding slash and for two years after the slash work was done.

Table V. - Comparison of annual Infestations in Area Surrounding Slash Before and After Slash was Made.

Designation			Totals		Percent of increase or decrease	
Area	Period	Year	No. Trees	Volume	Trees	Vol.
Intensive Zone	Before Slash	1918	330	281,000		
	" "	1919	437	372,000	x32%	x32%
	After Slash	1920	479	519,000	x10%	x40%
	" "	1921	227	247,000	-53%	-52%
Surrounding	Before Slash	1918	363	308,000		
	" "	1919	344	330,000	1 5%	x 7%
	After Slash	1920	702	632,000	x105%	x91%
	" "	1921	889	756,000	x27%	x20%

Table V. (Cont'd.)

Both Areas Total	- Before slash	1918	693	589,000		
	" "	1919	771	702,000	x11%	x20%
	After Slash	1920	1,181	1,151,000	x53%	x64%
	" "	1921	1,116	1,003,000	- 6%	-13%
Intensive zone- Including standing and slashed trees	Before slash	1918	330	281,000		
	" "	1919	437	372,000	x32%	x32%
	After slash	1920	825	975,000	x90%	x162%
	" "	1921	227	247,000	-72%	-54%

Chart No. 3 shows the data given in Table V. in graphic form. In referring to this table and chart it will be noted that the infestation in the intensive zones increased 10% in no. of standing trees and 40% in volume the first year following slash but during the second year the infestation in these zones decreased 53% in number of trees and 52% in volume from the preceding year. During the same period the infestation in the area surrounding the slash and intensive zones increased 105% in trees and 91% in volume during the second year. However, the infestation in the intensive zones, <u>including</u> the infested slash, showed an increase of 90% in trees and 162% in volume the first year following slash which was succeeded by a decrease from this high point of 72% in trees and 54% in volume the second year. These figures show that the highest relative infestation following slash occurred in the extra area surrounding the intensive zones which were closest to slash. This result was not anticipated as it was fully expected that a heavy concentration and resulting heavier loss would occur following slash in the intensive zones than in the more remote surrounding area. Just why the antithesis of this occurred is not thoroughly understood. It may be accounted for by supposing that the natural enemies of barkbeetles, Clerid predators, Hymenopterous and Dipterous parasites, were drawn from the more remote areas and were concentrated during the flight period following slash, work with the beetles in the intensive zones. These natural enemies being concentrated in the intensive zones would tend to check an increase in infestation in these areas and might contribute to a reduction but, owing to their diminished numbers, in the remote areas would have much less effect on the infestations here. We have nothing to support this theory more than that it is well known that these natural enemies are in constant attendance on the various species of barkbeetles. Another significant fact is that they readily come in large numbers to trap or slashed trees and that they breed prolifically in them.

Reference to Table V. and Chart 3 shows that the infestation in the entire area, exclusive of that in slashed material, increased 56% in standing trees and 64% in volume the first year following slash. However, this increase was lowered 6% in trees and 13% in volume the second year which would indicate that the infestation had begun to return to normal.

SUMMARY.

POINTS:

The results bring out the following pertinent points:

(a) The greater attractiveness of slashed trees over standing trees. The great concentration of beetles in the slashed area.

The high relative mortality of broods developing in slashed trees. This mortality amounted to an average of 74% in D. brevicomis and 62% in D. monticolae.

That the high rate of mortality is probably influenced or caused by adverse physical conditions in the slashed trees and natural insect enemies.

That trees felled during May and June put out slightly heavier broods than trees felled at other periods and that broods which develop in these trees are attended with less mortality.

(b) That, exclusive of the slash, the subsequent infestation following emergence from slash, is relatively less in the stands immediately adjacent to slash than in the more remote areas.

That this result is probably due to a concentration of the natural enemies of the beetles attacking in the slashed and adjacent areas.

That these natural enemies breed profifically in slashed trees and usually arrive in large numbers soon after a tree is felled.

That the infestation in the general area increased during the first year following emergence from the slash but was followed during the second year by a slight decrease.

That the data indicate a return to normal conditions after the second year.

(c) The study is not yet completed. Complete data for Sector 1 only has been made available.

That subsequent studies or their results may modify the above analysis.

BIBLIOGRAPHY

The following reports and memorandums in the files of the Ashland Station deal directly with the study or contain data pertaining to it.

1. Preliminary Report - A Study of the Greenspring Highway Road Slash
   By - J. E. Patterson, February 1921.

2. The same. Second Report. Data for 1920.
   By - J. E. Patterson, December 24, 1921.

3. Artificial Attraction of _Dendroctonus brevicomis_ to Living Pine Trees.
   By - J. E. Patterson, December 14, 1920.

4. Attraction of _Dendroctonus brevicomis_ to Felled Trap Trees.
   By - J. E. Patterson, December 14, 1920.

5. Brood Statistics on _D. Brevicomis_ and _D. monticolae_. (Data pertaining to Southern Oregon)
   By - J. M. Miller.
   F. P. Keen.
   J. E. Patterson.

MR MILLER: I would like to ask one question. In the report you speak of mortality, but does that mean total brood mortality or a percent of what the normal emergence would be?

MR PATTERSON: The normal emergence was taken at 80 beetles per square foot of bark. The brood mortality is a percentage of that emergence and in the case of monticolae it was based on an emergence of 60 beetles per square foot of bark. In addition to that there is the normal brood mortality such as occurred in any other standing trees.

It seems as though you got in each sector an increase in the intensive zone the first year following the slash.

MR PATTERSON: We have an increase in the intensive zone in the first sector only while we haven't any data for the second sector yet; it is too early to get that at the present time, but in sector One we had an increase in the intensive zone but it was not as great, relatively, as the increase in the surrounding areas.

MR MILLER: You couldn't detect any localization of the emergence from the slash logs?

MR PATTERSON: We had some groups in some parts of the area as a result of the first attacks following emergence from the slash. In certain parts of the areas some groups contain as many as 57 trees that was the highest. The following infestation dropped back to a normal condition.

THE SECRETARY: As to the mortality, in what stage did you think that came?

MR PATTERSON: During the development of the brood.

THE SECRETARY: I was wondering whether it was in the early larval stage?

MR PATTERSON: We didn't detect that. There were predators present in large numbers.

MR EDMONSTON: Did you make any note of any loss in the predators in mortality?

MR PATTERSON: We did not.

MR BURKE: Did the slash attract the beetles to the surrounding area? Did it infest the standing trees in the vicinity of the slash? I don't mean an increase, I mean a concentration.

MR PATTERSON: It did.

MR EDMONSTON: In the vicinity of the slash your increase was more?

MR PATTERSON: After the emergence from the slash the increase was greater than beyond the intensive zone.

MR EDMONSTON: You found an increase in the outer zone?

MR PATTERSON: Yes.

MR JAENICKE: I would like to say a few words in regard to the applicability of these slash studies to forest management generally.

There are two or three problems in forest management on private and government forests, the solution of which depend upon conclusions that are reached by an adequate slash study.

In the first place throughout the yellow pine forests of the west, there occassionally occur large and destructive windfalls as the result of cyclone winds. Not infrequently these heavy windfalls have been followed by attacks of Dendroctonus species in the windthrown trees and by subsequent killing of considerable standing timber by the beetles. In such cases, the question has arisen whether any ~~standing timber~~ prevention measures could have been taken to protect the timber still standing.

Throughout the yellow pine forests small cuttings of a sporadic nature are constantly taking place. Again and again our attention has been brought to the killing of reproduction and merchantable timber by bark beetles following these cuttings and adjacent to them. Fortunately, in the majority of cases the damage is confined to reproduction or small stuff under 10 inches in diameter. In studying those situations, I find there are two characteristics of the damage. In the first place, the damage very rarely continues after the first year and that therefore the initial loss is practically the only loss. In the second place, the Dendroctonus and Ips species which cause these killings ordinarily do not emerge in appreciable numbers from the reproduction and small trees which they kill. Whether or not special brush disposal measures will prevent these losses, has oftem been under consideration.

It has been observed by forest officers in the yellow pine forests of the Rocky Mountain and Pacific Coast regions that the virgin timber adjoining <u>continuous</u> logging operations is especially free of insect attacks. How far into the virgin timber this absence of heavy infestation occurs in such localities, is a matter of mere conjecture. No data are available on this point. But the matter which causes concern is that on the cut-over areas the seed trees left on National Forest sales suffer, to a noteworthy degree from insect attacks. These losses in seed trees through bark beetle activity (perhaps flatheaded borers are involved also) constitute a very real and vital problem in the perpetuation of the yellow pine forests. We ought to know whether there is a way to prevent these attacks. The problem seems to be tied up with slash disposal methods.

In these parts of the Pacific Slope yellow pine forests where two generations of <u>D. brevicomis</u> occur in a year, any method of slash burning to kill

the beetles involves the burning of slash at two times of the year, namely, either in the fall or very early spring, and again in the early summer. The summer burning may prove to be a difficult thing to carry out even if shown to be entomologically desirable. However, there is a rapidly growing feeling that the beetle aspect of the slash problem is worthy of serious thought in spite of the practical difficulties involved in the problem. It is largely because the beetle damage doesn't occur with sufficient regularity in the absence of special precautions in disposing of slash to warrant such special measures in every case. It is evident that in order to burn the slash in early summer, for example additional expense is involved. The question then comes up whether this additional expense is warranted by the beetle damage which may or may not take place if the slash is not burned, at any rate, this financial aspect of the disposition of slash from the entomological standpoint is one that is constantly puzzling forest officers on yellow pine sales on the National Forests.

MR KEEN: I am afraid we are missing the point of these discussions if we don't try to arrive at some conclusions. We constantly run into the problem of slash disposal and I think the object of these meetings should be to arrive at some general conclusion with the best of our present knowledge as to what should be done under certain circumstances.

For instance, Mr. Kimball tells me that he is going to send a crew out there next year to treat the slash on Mr. Patterson's slash study area. Is that a good thing or not? Would you recommend it?

MR PATTERSON: Some of the slash is on the ground now, but it has not all been laid down; the slashing will be completed by spring, it will be infested this coming season. I couldn't say whether it would be a good thing to treat it or not. I don't think it would be of any particular advantage.

MR EDMONSTON: I have here part of a paper which I have prepared and I will read the part relating to brush disposal now. (Mr. Edmonston reads the following:

Brush Disposal in Relation to Insect Infestation.

By
W. D. Edmonston.

We have given this matter of brush disposal a deal of thought and we expect to continue to do so whenever the opportunity presents itself as it did in this forest. No Dendroctonus were found in any brush or slash on any of the sale areas. Secondary insects were common but not abnormally so considering the ample food supply; Ips. Pityopthorus, Cerambycids and Buprestids were mostly in evidence. The red tuprentine beetle (Dendroctonus valens) was common in freshly cut stumps; it is following right along with the cutting just as the others are doing.

At the present time the secondary insects are of great value as they hasten the decay and more rapid disintegration of the brush, especially, Ips; these insects which as adults bore through the bark and raise a brood between the bark and the sapwood admit other agencies which result in still further decay. The secondary insects in this case seem to be doing more good than harm; the small amount of damage they might be capable of is well offset by the good they do which will continue for many years and quite as long as the present system of cutting is continued.

The disposal of brush by burning, unless as a fire prevention measure, is unnecessary and may do more than harm than good unless it could follow the cutting within a few weeks; in most cases it does not except in the winter months. Nearly all the secondary insects that are found infesting the brush or slash raise a brood every 30 to 40 days during the summer months, or from May to October, and in this way keep close up with the cutting and months ahead of the brush burning. Round and flatheaded borers are entirely secondary in pine slash and these and some very important predatory insects are all that late brush burning would destroy. Areas logged three to four years ago show no injurious effects either from brush left on the areas or from the thinning of the stand.

MR PERSON: Perhaps some of you have seen the article by Dr. Graham, of Minnesota. He has made some studies in Minnesota along the same line that Mr. Edmonston touched upon where they were logging in the state park and they followed up their logging with a different system of disposal of brush and he found that in the cases where the brush has been burned, the large butts, stumps and tops where the injurious insects would naturally breed, were the ones not disposed of by the brush burners, and the stuff that was disposed of was of no importance in insect control.

THE CHAIRMAN: If we had time I would like to go into this question of slash more fully and take up the definition of the word "slash". Slash means everything that is left on the ground; it includes culls, logs, large chunks and large tops. In thinking of slash we must think of everything that is left on the ground. I thought for a while that it was just the tops and the brush.

MR MILLER: I would like to follow up Mr. Keen's suggestion and see if we can't reach some conclusions either now or later, in the conference as to the policy that we should follow during the next few years in regard to this problem until such a time as our investigations may throw more light on it. Everywhere we find our hand forced on this proposition. We all have problems of our own and we are asked to make decisions on this question and what are we going to do?

We might leave it over until the last day of the conference and then arrive at some definite conclusion.

THE CHAIRMAN: I have some data to present later which I would like to have considered before a decision is given on this subject.

MR EDMONSTON: I don't think we can arrive at a general rule to follow in all cases. It seems to me that you have got to make an examination on the ground to determine each case as it comes up. You can't make hard and fast rules to govern all cases.

MR MILLER: That is what the forest service wants us to do.

MR EDMONSTON: It is utterly impossible. I am just expressing my opinion.

MR BURKE: There are several problems here: The case of the Forest Service where they leave seed trees -- it seems to me that my experience would say not to burn the slash for two reasons: One is that the chances are that those seed trees are not killed from the insects developed from the slash, but from the attractive influence of putting that brush there and the burning often attracts the insects, certainly that species of insect that is attracted by scorched timber.

THE CHAIRMAN: The seed tree is a problem which the forest service throughout the country is worrying about.

MR EDMONSTON: Don't you think an examination should be made before we pass on a matter? If that is right, that settles it all.

THE CHAIRMAN: I hardly think so, because after it is time to examine slash in a logging area to see whether insects are attacking it or not, then it is too late. What they want to know is, can we see far enough ahead to tell them what do to prevent such trouble?

MR EDMONSTON: We would be expected to pass upon something that we didn't know about.

MR JAENICKE: I am going to make my remarks very brief. This discussion seems to have been confined to the features of the problem as they apply to the National Forests. With the probable advent of some sort of a national forestry program, it may become financially worth while for the private owners to leave their cut-over lands in the best possible condition and to protect the reproduction until such time as the state and federal lands take them over in exchange for cash or stumpage. As a consequence, it is not unreasonable to expect that entomologists are going to be called upon to give specific advice on the feasibility and manner of avoiding the beetle damage which seems to so often accompany and follow logging in yellow pine everywhere in the West. And in anticipation of this call for help, isn't it possible for us to recognize four or five common sets of conditions and lay down the needs of each of these <u>now</u> with the information already available? For example, a cutting that continues for only a year, represents one problem while the continuous logging operation involves an entomological problem of a different sort. Occasionally large windfalls occur, the government and private owners need to know what infestations can be expected to follow such windfalls and what measures are necessary to lay down blanket rules which will cover all these conditions. By dividing the problem into four or five different types of conditions and then making recommendations for each, it ought not to be difficult to put the existing data in usable form.

THE CHAIRMAN: The point is that this Bureau can't make a rule which will apply to every condition. It wouldn't be done. What we must know is that is going to happen if slash is left or if slash is taken care of, then we can apply that knowledge to these various conditions.

I want to caution you again about keeping on the subject. The next paper is by Mr. Edmonston: <u>D. Ponderosae</u>.

SUMMARY

Artificial Control

Solar Heat Method: Bark temperature of 110° will kill full grown larvae, pupae and adults. Such bark temperatures may be reached when the air temperature is above 85°. The method has limitation. It depends upon climatic conditions for success; is complicated and requires especial training on the part of the cruiser; can only be used on logs under 30" d.b.h., and is not reliable even in the Sierras after September 1. Cloudy weather renders it ineffective. It can be used to good advantage to supplement the burning method. It was not successful on the Southern Oregon-Northern California project.

Burning Method: Effective burning involves keeping the log slightly off the ground; confining the fire to small area uniformly distributed along the length of the trees; and peeling at least half of upper part of the log.

Economy of methods: The most economical method is burning without a fire line, using a three-man crew.

Where fires tend to spread it is more economical to use a fire line although it is found to cost 42 cents per M. During dry weather bark may be burned in piles at an extra cost of 73 cents per M. over the solar heat method. Small logs are most efficiently burned in piles.
Summer night burning has been used successfully in the Sierras.
Summer burning should only be done with the fullest cooperation of the fire protective organizations responsible for the area.

Immersing in Water: It has been found that, three or four days immersion is not enough to kill the larvae pupae or beetles.

SOLAR HEATING METHOD
USE AND LIMITATIONS.
By
J. M. Miller.

During the fall of 1919 a series of tests were made at the labratory at Ashland to determine what temperatures would effectively kill larvae of brevicomis. The tests were made by exposing the larvae both in the bark and out of the bark to warm air temperatures. It was found that in the bark, mortality occurred between temperatures of 110 and 115 degrees. The effect of varying temperatures upon larvae which were taken out of the bark could be easily watched and the following results were obtained:

70 to 80	degrees	F.	Larvae normall active.
81 to 85	"	F.	" " "
86 to 90	"	F.	Activity increases
91 to 95	"	F.	Maximum activity (Exposed larvae maintain rapid and continuous movement)
96 to 100	"	F.	Slight activity (Exposed larvae become dormant after brief exposure, and low mortality may occur)
100 to 105	"	F.	Activity ceases (larvae become dormant after brief exposures. Complete mortality of exposed larvae occurs within 30 minutes exposure to 105 degrees F.)
106 to 110	"	F.	Fatal after short exposure. Few larvae survive after temperature reached 110 degrees. Exposed larvae do not survive 110 degrees F.
111 to 115	"	F.	Fatal temperatures (Larvae become discolored after brief exposure)
115 to 120	"	F.	Fatal temperatures (Larvae become discolored after brief exposure.)

On these tests the larvae were exposed to warm dry air. Under these conditions the humidity becomes very low as the temperature rises above 100%. The loss of the moisture by the larvae when they reach the higher temperatures undoubtedly has much to do with their mortality.

During January 1921 a few tests were made at Northfork with the purpose of determining the effect of the temperature alone where humidity is constant. A series of larvae were collected from the bark and placed in glass vials which were sealed with parafin and immersed in water, the temperature in the vials was controlled by bringing the water through the desired range of temperatures.

Under these conditions it was found that:

1. Larvae remain active up to about 105 degrees.
2. Larvae become dormant at about 108 to 110 degrees but after short exposures will recover and continue development.
3. Larvae exposed to 114 degrees remain dormant for a long period if exposed for 20 minutes at this temperature they remain dormant for an indefinite period but eventually die, one lot removed from the test Feb. 28th, were still in the same dormant condition when examined June 9th, nearly five months later.
4. Mortality sets in between 115 and 118 degrees. No larvae survived an exposure to 118 degrees Fahr.

During the following season of 1920 the solar heat method was put to an actual test on the San Joaquin Control Project. The method was used all through the month of June, July, August and part of September on summer control work.

In addition Mr. Patterson made a series of tests on the Jenny Creek Plateau at Ashland.

EFFICIENCY OF SOLAR HEAT METHOD OF CONTROL.

Burning infested bark was continued as late as possible during the spring period. On the whole, this is considered the least expensive and most effective means of destroying the broods. It was still possible to do some burning in June, but the fire risk is so great that all control on this project should use the solar heat method during June, July and August.

Studies of the degree of heat reached by the exposed bark and the effect of this heat upon the broods were made at intervals during the summer. Results from two of these tests are shown in charts.

The following maximums were reached on dates in June, July and August:

Date	Maximum air temperature	Maximum bark temperature
June 23	34 Degrees	132 Degrees
July 17	96 "	128 "
Aug. 17	96 "	128 "

It was found that the amount of heat absorbed by the bark varied from day to day, according to atmospheric conditions. The degree of heat also varied in different sections of bark, and bark which had become very dry absorbed heat faster than that which was more moist.

The angle of exposure to the sun's rays also has a very marked effect upon the degree of heat absorbed by bark sections. A south slope is therefore the most desirable location for bark exposure. During the summer months, however, any exposure except a northern one will result in bark temperatures sufficient to kill the broods. After September first, however, as the angle of the sun's rays become lower it is difficult to secure effective bark temperatures unless the sections are tipped directly to the south.

In all tests made, no broods were found which survived, even for a short period, in a bark temperature of 120° or more. Mortality, however, occurs between 110° and 120° and increases according to the length of exposures. It was found that exposures of one or two hours during the middle of the day was for all practical purposes, sufficient to kill the broods in the bark.

A much more detailed and highly analytical study of this method of control was made by Mr. J. E. Patterson at Ashland, Oregon. His experiments were carried out in the field at a point about 400 miles north of the San Joaquin area and at an elevation of 4000 ft. The maximum air temperatures were several degrees lower than those obtained at Northfork, and the higher latitude and elevations of the Ashland experiments put this method to a more severe test than occurred under conditions at Northfork. Mr. Patterson's conclusions are stated by him as follows:

"That the efficacy of this method of control of Dendroctonus brevicomis is well established. That in this latitude the method is productive of results fully equaling those of the established method of burning the infested bark.

The method is practicable and efficacious throughout the summer period when the maximum air temperatures range between 80 and 100 degrees.

The method is also applicable during the fire season, when burning infested bark would be extremely hazardous, and in forested areas where fire danger is excessive.

A certain range of maximum bark temperatures is a requisite to produce a sufficiently high brood mortality to make the method successful in application. These temperatures normally prevail during the summer period throughout the pine forests of this region. Bark temperatures above 115 degrees are productive of satisfactory results.

The tests indicate that:

Bark temperatures below 90° are not sufficient to appreciably effect the mortality of the broods.

Critical bark temperatures range from between 100° and 115°, forty to ninety percent of the broods are killed within this range of temperatures.

Bark temperature above 120° are approximately 100 percent fatal. Prolonged exposures at bark temperatures of 115° are 100% fatal. Absolute mortality is assured with one hour's exposure at 130° bark temperature.

Safe temperatures prevail before 10:00 A.M. and after 4:00 P.M. During these periods the maximum bark temperatures do not exceed 100 degrees.

Critical temperatures prevail during the periods from 10:00 A.M. to 11:00 A.M. and from 3:00 P.M. to 4:00 P.M.

The minimum duration of exposures, 95 percent or more fatal to the broods is 30 minutes.

During the early larval stage(before the small larvae have entered the central layers of the outer bark) one day's exposure of the bark under normal forest conditions, and even in shaded positions, is 100% fatal to the broods.

The percentage of relative humidity present in the air during the period of the tests did not appear to be a factor noticeable influencing the mortality. It would appear that a high relative humidity would lower the mortality at a given bark temperature. However, this was not determined, though the tests indicated that the bark temperatures and the duration of the exposure were the two factors controlling the mortality."

During the progress of the work at Northfork, a check was made on actual results of the control work under this method by later examination for exit holes in the exposed bark of most of the treated trees. It was found that all bark properly exposed during June, July, and August showed satisfactory results. Bark exposed after September 1, frequently failed to show good results unless the sections were tipped toward the south and exposed without shade the greater part of the day.

Burning of infested bark was resumed about the last of September and early rains made it possible to continue this method during the remainder of the working season.

The method has been used on the San Joaquin Project during the seasons of 1921 and 1922 with this additional experience has been gained a much better knowledge of the uses and limitations of this method.

General conclusions:

1. Solar heat can be used to supplement the burning method but whenever burning is safe it is the most satisfactory to use. This is because it is unnecessary to peel the lower part of the log when fire is used which saves considerable labor. Then fire cleans up limbs and other debri making it easier to do a cleaner job.

2. Periods of cloudy weather may sometimes occur rendering the solar heat method ineffective for several days at a time.

3. Solar heat is not reliable even in the Southern Sierras after September 1st, as effective temperatures will not be reached unless the bark is tipped at an angle toward the south.

4. Solar heat cannot be employed effectively in heavy timber as large logs cannot be rolled so as to peel the under side.

5. Effective use of the method is rather complicated and requires special experience and training on the part of the crew.

6. The method can be used to good advantage only where climatic conditions insure clear hot weather, where the ground cover is open, and on trees of less than 30" D.B.H. which can be rolled over so as to remove the bark from under side of the log.

THE CHAIRMAN: The paper is now open for discussion.

I might say that up in Coeur d'Alene during this last season we conducted similar field tests by exposing the bark to the sun. We had the same results, practically, as they did at Northfork and Ashland. With an air temperature of 85 degrees, we secured a bark temperature of 128 with 100% mortality with about 122 or 123. The only interesting part to our experiment was that I waited until bark could be secured which contained both new adults and pupae which we both killed by the treatment.

MR KEEN: The sun curing method was used on the Southern-Oregon Northern California Project during the last year and for all practical purposes it was a failure. The hottest month of the year at Klamath Falls had a mean temperature of 72 degrees. It requires an air temperature of 85 degrees in order to get a sufficiently high temperature in the bark to kill the beetles. With a mean temperature of 72 degrees it is not hot enough up there to make the method effective. It is doubtful whether over 40% of the beetles in the bark exposed were killed. Examination of the spread bark showed it to be studded with exit holes. The low returns in timber saved were also evident when the fall surveys were made. There was a slight reduction in the summer work areas and the new infestation was right around where trees had been treated, while on the spring treated areas a big reduction was evident and new infestation was found away from the treated areas or where trees had been missed. A spotted map of these areas tells the whole story. With about 40% of the beetles killed we have secured a 40% reduction.

THE CHAIRMAN: I think thereby hangs the success of the whole system--what our average temperature is going to be. I don't think we can go ahead and recommend this method without finding out more about our temperature during the summer and exposures in the elevations.

MR BURKE: I have just a little matter of historical importance as to who really discovered the solar heat method. I have a letter from Ranger Baldwin, on the National Forest in 1905; the letter was to Dr. Hopkins in September, 1905 .

> "As I have already reported the bark beetles, especially the tomcus, in the larvae stage is very sensitive to heat. I find in the case of slash cut after July 15th, and exposed to the direct rays of the sun, both larvae and, in lesser degrees, the adult beetle are shriveled up and killed by the heat. I am satisfied that all we have to do to kill the Tomicus is to subject the outside bark to moderate heat. This also practically seasons the sapwood and the log can be utilized as fuel later."

You might say that this is something of a discovery that has been lost for about fifteen years.

THE SECRETARY: It seems as though the bark which remains on the underside of an infested tree and is not treated but burried in the ground would be quite a factor in the success of the control. I was wondering if anyone knew if the adults could emerge through the soil from a tree that is lying flat on the ground. That is, what percentage of adults would get out?

MR PATTERSON: I haven't any data on D. brevicomis, although I have on the D. valens. D. valens will attack stumps and the adults will construct galleries along the roots of the stumps and I have found two or three instances where they have constructed galleries for twelve or eighteen feet from the stump and produced broods which emerged through the ground. I have no data on D. brevicomis.

MR MILLER: That is an experiment which should be carried out and which we have neglected too long, like we have some other things. It could easily be done by turning over some of these logs that were exposed to the solar heat last season and making some counts.

MR PERSON: Did you try turning the inside and the outside of the bark toward the sun?

THE CHAIRMAN: As I understand it, if you put the outside toward the sun you get no results at all. Is this correct Mr. Miller?

MR MILLER: It apparently makes little difference. We have tried it both ways.

THE CHAIRMAN: Do you get the same mortality with the outside of the bark turned toward the sun?

MR MILLER: It is just as effective either way.

MR BURKE: At Northfork don't you have more temperature than you need? In Idaho you might have only enough temperature to kill them, if they are close to the surface. Where are they -- closer to the outside or closer to the inside?

THE CHAIRMAN: Closer to the inside.

MR PATTERSON: There is one advantage of placing the outer surface uppermost, it doesn't warp in the sunlight as quickly. We found that out in control work.

BURNING METHODS
VARIATIONS AND ECONOMICS OF USE

(By - F. P. Keen)

At present the method of destroying of bark beetles such as D. brevicomis by burning the bark is the most effective known method of artificial control.

The usual method consists in felling the infested tree, peeling the bark from the upper half of the log, cutting off the larger limbs and top and piling them along the log and then after constructing a fire line, burning the entire mass.

The securing of complete burn of the infested bark is the vital part of the whole process and should be watched with as much care as the spotting of the proper trees.

In using the burning method there are two points which must be borne in mind:

1. The effectiveness of the method in the burn obtained.
2. The economy of the method.

Since most of you are as familiar as myself with the burning method I will only touch on the variations which have to do with the effectiveness of the burn, namely:

1. A better burn is obtained if the log is kept slightly off of the ground. In the case of limby trees, lower limbs, should be cut off so the tree will settle closer to the ground rather than attempt to burn in midair.

2. The fire should be confined to a small area around the tree. During the wet season plenty of pitch should be used and lots of limbs and brush scattered along the entire trunk of the tree. Too often a good burn is secured in the top of the tree but the large butt end is left without much fuel and hence only gets scorched.

3. At least half of the upper side of the log should be peeled to insure a good burn and if the log is large and considerable distance from the ground even more than half should be peeled.

3. Economy of Methods.

The main object of this paper is to discuss the economy of certain variations in the burning method.

1. Burning with and without fire lines.
During the spring the work on Area I was carried out using 2 man crews

and without building fire lines while fairly early in the season on account of the fire hazard three man crews were used on Area 2 and 3. The comparison in the costs were as follows:

Average cost per M.B.M. Areas 2 and 3		$5.90
" " " " " 1		5.66
(Excepting Camp 13)		
Saving in cost per M.		$ .24
Total apparent saving by method in treating 1,805,760 B.f.		433.38
Deductions from saving		
Fighting fires, 2 men for 2 weeks	$140	
Loss of timber 33,670 B.f.	101	
Damages to country road	85	326.00
Total net saving		$107.38

This net saving does not take into consideration the damage to the reproduction, the menace from beetles concentrating in the burned areas, nor the tremendous risk involved in letting fires run wild late in the spring season. Altogether it can not be considered that it is an economic proposition to do control work without making fire lines along when they are necessary.

It is very difficult out of the mass of data available to get the cost of making fire lines, since there are so many other factors that must be taken into consideration.

Diagram No. 1 gives a comparison between different areas in spring and fall work with three man crews. If the total difference can be charged to the cost of making fire lines then we have a total cost of:

No fire lines - 2.6 trees per day @ $6.00 per day - $2.31 per tree
With fire lines - 2.2 " " "@ $6.00 " " - $2.73 " "

Cost of fire lines .42 per tree or since the trees average 1000 B.f. a cost of 42 cents per M.

(b) Burning bark in Piles:

During September it was found on the Southern Oregon-Northern California Project that on account of the cold weather the sun curing method was not at all effective. Since the forest was still very dry it was dangerous to resort to the general methods of burning therefore a modified method was used.

After the trees were felled gunny sacks were laid along the sides of the log and the bark peeled onto them; it was then gathered up and piled in a safe place with a wide fire line and nothing but the bark was burned.

The following tables give a comparison of the costs of this method with the cost of the sun curing method. The figures are for the same crew working under identical conditions with the exception of the method of treating and hence the comparison is a good one.

Sun curing Method -- Three Man Crew -- Camp 32 -- Summer Work.

Date	Trees	Volume	Man Min.	Man Days	Min Per Tree	Min Per M
June 24	9	16,460	2790	18	310	169
July 1	16	16,460	2325	9	145	141
July 15	25	29,430	4875	18	195	165
July 22	14	14,130	2429	12	173	172
July 29	20	19,130	4975	18	249	260
Aug. 5	25	23,270	5965	18	238	256
Aug. 12	37	32,820	6430	18	174	196
Aug. 26	46	44,160	7310	18	159	166
Sept. 2	34	30,790	5130	17	151	167
Sept. 9	33	36,510	5875	12	178	161
	298	291,310	51,079	176	172	175

BARK PILED AND BURNED

3 Man Crew.

Sept. 9	8	11,460	1850	6	231	161
Sept. 16	15	21,200	4650	18	310	220
Sept. 23	33	30,500	5090	17	154	167
Sept. 30	14	22,290	6850	18	490	307
	70	85,450	18,440	59	264	216 1.2
Total	368	376,760	69,519	235		

Summer Method Av.	Trees Per Man Day	Volume Per Man Day	Cost Per* Tree	Cost Per M
Sun Curing	1.7	1650	5.28	5.34
Bark Piling	1.2	1450	7.34	6.07

*On basis of $8.80 per man day treating time.

MR PATTERSON: I want to ask Mr. Keen just how he burned the bark in pits, whether a pit was dug for the bark or whether the bark was just placed at a distance from the tree and burned?

MR KEEN: Simply a wide fire line was cleared out in some opening near the tree; no pit was dug.

MR MILLER: Did you make any effort to do night burning?

MR KEEN: No, not so far. Mr. Black expects to try out that in connection with his spring operations.

MR MILLER: We found that to be safe in the Sierras for the reason that the nights there cool down and there is very little wind and burning, even in dangerous places, can be carried on during the summer provided there isn't any old debris or down logs or snags near your tree that might get the fire into them.

MR KEEN: Do they watch it at night?

MR MILLER: No, only about an hour.

MR PATTERSON: We have used the night burning method on the Antelope Project to some extent. It was satisfactory with the exception of where there were standing snags close to the trees to be burned. Wherever the fire got into the snags it was a serious proposition. Where there were no snags it was satisfactory.

MR EDMONSTON: Would you have to have extra men? Or would you work them all day and all night?

MR KEEN: Mr. Black is planning to hire extra men for his night burning. He will expect each crew to prepare the fire line around the tree during the day and touch it off before going into camp. He will put two of the best men on the fire work; they will look after the fires early in the evening and again in the morning and that will be their special and only job.

MR BURKE: As I understand from all these discussions the sun curing method is really not feasible, or necessary since you can burn on any project?

MR MILLER: The one conclusion stated in regard to the use of that method is that it can be used to supplement the fire in case you have a tree that should be treated in a situation where it is very dangerous to burn; we run across those occasionally in our work. In fact, nearly 50% of our trees on the San Joaquin project in this summer's work were sun cured, but the largest

volume of the timber that was treated was burned; we used the burning method for the big trees. On the whole we prefer to use the burning method whenever it can be safely employed.

MR JAENICKE: I think the most important thing, of course, when burning is done during the fire season, is that close cooperation be maintained between the men who are doint it, those responsible for the burning and the Fire Protective organization. In other words, it is very necessary that the Supervisors of the forest, for example, know constantly just exactly where this burning is taking place so there will be no confusion between his lookouts and the consequent reporting of smokes which result from legitimate burning. If this thing is gone at carefully, if the burning is done on experimental lines at first then I think we can gradually get the confidence of the private and government forest protective organizations.

I don't think I would recommend the use of burning during the fire season, for example, or night burning on a wholesale scale unless it was previously demonstrated that it was a safe thing to do. One serious fire resulting from the "bug" work will do more to counteract what good we may do in the course of several seasons' work.

These various protective organizations, private and government, are trying desperately to maintain high standards and a good deal of competition exists between the organizations as to the cause of fire--whether themselves or the bug men. It doesn't make much difference. We may consider ourselves responsible for fires, but it is a black mark against the organization which effects us.

THE CHAIRMAN: There is that point to be considered. Our state laws prohibit fires and it doesn't seem to me that you can get around it. If it is necessary, then it must be done. If we can get around it, it would be better to avoid public criticism which would be just in a way.

CONTROL THROUGH SUBMERGING

By

J. M. Miller.

The method of submerging logs in water has been recommended as a method of control. We have always assumed that these insects could not survive under water and this submerging for a few days would do the work. In a logging operation we were supposed to get a certain amount of control if the infested logs were carried into the water, such as dumping them into the log pond at the mill.

What we found out on the Arrowhead Project when we attempted to apply that method was that the brood did not die after the logs had been in the water for three or four days. On taking them out we found the broods dormant but after a few hours in the air all stages recovered. As yet we have failed to show what period of submergence is necessary to kill the broods.

METHOD OF EXTENSIVE SURVEYS

By
F. P. Keen.

The making of extensive insect surveys is entering the realm of an exact science.

For a great many years, when insect surveys were not plentiful most any method which suited the judgment of the estimator was the one adopted. Usually such survey consisted of giving the country the "once over" and setting down a figure for the insect loss which represented simply an expert opinion on the situation. As the work has progressed in the last few years, the Bureau has been called upon more and more to make extensive surveys as a basis for control recommendations.

The methods used have gradually evolved until now we are in a position to go about such work in a very methodical and systematic way. There is no question but what improvements can still be made but the method which I will outline is the best results of our experience so far.

The General Situation to be Covered.

The method to be used will vary considerably with the country and topography to be covered. The method outlined is primarily adapted to the yellow pine belt of the Sierras in California and the Cascades of Oregon. I am not prepared to say that it can be used in the Lodgepole areas of Idaho and Montana or other tree species of the west.

Size of Crew:

The first thing to be considered is the size of the crew to be used. The factors which will determine this are the character of the country to be covered; the time available; the funds available and the accuracy desired.

One, two, three and four man crews have been used. One man can be used if only a rough approximation is desired, or if a more accurate survey is desired and the time element is of no consideration. Such a man should be only one very familiar with survey work and estimating in the country involved. The personal factor in the estimate is a large one and the accuracy is indeterminate.

The best example of this method, is on the River Rogue Area, where a large part of the survey work has been done by P. S. Sergent. The funds available were limited; time was not a vital consideration and one man could do the work since the country was thoroughly familiar to him.

In a new country, it is almost imperative to have two men, one of whom is acquainted with the country, the roads, camping places, etc., and the second man familiar with survey work; and estimating insect losses.

This was the method used during the first survey of the Southern Oregon-Northern California Project, and is the one adopted by Mr. Jaenicke in his cruise this fall of the areas adjacent to that project. This size crew has some points in its favor, but it is far from ideal. For example the cost of the fall survey

of 1921 was $2444.29 and the percent of the cruise was .94%; the cost of the survey of 1922 using a four man crew was $3681.34 and the percent of the cruise was 5.5%, or nearly five times as intensive with only one-half again as much cost.

Three or four man crews were used on the Southern Oregon-Northern California Project survey of 1922 and it is the judgement of the writer that the three man crew is by far the most efficient.

In such a crew, one man should be capable of planning and carrying out the work and with one other capable man do the spotting and estimating work. The third man should be capable of running a compass and preferably also capable of spotting. At least one man in the party should be familiar with the country to be covered.

Since this size crew is the most efficient, I will discuss the methods to be followed by them in covering an area similar to that on the Southern-Oregon-Northern California Project.

Preparation:

Before beginning the survey the estimator should secure a good map of the area to be covered, showing section lines, roads, trails and general topography. If possible, a good type map should also be secured from the Forest Service or other agencies, which will give the location and boundaries of the types to be cruised and the approximate volume per acre of the tree species involved.

Camp equipment, record forms and cruising tools, a list of which is appended should be secured and assembled in advance.

Procedure in the Field:

From the general lay of the land as seen from ridges, and with the use of the maps, unit boundaries should be established to include approximately 30,000 acres or less, which, because of the topography, the character of the stand, presence of large open valleys or the localization of insect centers naturally divide the country into what might be considered as entomological units or units which it seems reasonable to assume could be treated by control operations without reference to the rest of the country.

Cruising a Section:

On arriving on the area, the estimator should select a typical representative section, locate a section corner and then proceed with the crew to mark up all of the infested trees of the last generation or last yearly loss which is evident on the area. One man acts as compassman and runs strips back and forth through the section, running twice through each forty. One spotter works on each side of him, marking all the insects killed trees within a ten chain strip. Trees should be blazed and numbered and listed by the spotter as to the year of loss,

diameter, height and volume; and mapped by the compassman as to its location in the section. In the case of D. brevicomis, it is well to list separately the trees killed by the summer and overwintering generations.

The section in each unit should be cruised and worked, or marked in this manner.

Estimating by Strip Method:

After one section has been cruised, one day should be spent by all three members of the crew in running sample strips throughout the rest of the unit.

Starting from a known section corner, each man should be equipped with a compass, tally register, cross-section note book and map of area and start out in a different direction so as to cover as large a part of the unit as possible.

Distance is checked up with pacing; section lines are followed if possible, and the insect killed trees counted within five chains on either side of the line. Trees are not blazed or marked, but are simply tallied up in the notebook with a map of the route taken, topography and type data.

Each evening these separate tally sheets should be consolidated by the estimator on the one inch to the mile township plats. These maps should show the type, roads, trails, etc., route taken by each man and the number of killed trees to each mile of strip.

Office Work:

Later in the office, by simply reviewing the township plats, which contain all of the data, the cruised section data, type and timber acreage data, an estimate can be made for each section of the township.

The tabulation of these estimates will give the number of trees killed on the area, using the average volume found on the cruised section, the volume killed on the area can be computed and from the township plats the timber acreage can be computed.

Results:

This method will give quite an accurate estimate of the area in question, representing about a 5% actual cruise, which should not exceed a 10% error. So far no standard form of tabulating these data have been decided upon. Such action is highly desirable in order to coordinate the data from the various surveys; and it is hoped that some standard form will be adopted in the near future.

Estimating by Viewing Method:

In country of rough topography, fairly satisfactory estimating may be done through viewing.

In using this method the route taken should be along ridges or through

open valleys where a good view may be had of the timbered area. A certain slope or area, not more than 2 miles away, which can be viewed is marked out on the map of the area and the number of red-top trees which can be seen either with the naked eye or with the binoculars are counted. The section which was cruised should also be viewed in this manner and a factor, which is the ratio of the total trees on the section divided by the number viewed, determined.

The resulting figure should not be used literally but should be modified by the judgment of the estimator as to the character of the light and distance away and the general type of the timber area viewed, before arriving at an estimate of the amount of infestation.

<u>Referances:</u>

A. J. Jaenicke, Sept. 1921 - Suggestions as to data to be collected on Southern Oregon-Northern California Proposed Insect Control Project during progress of the Extensive Insect Survey.

F. P. Keen, June 14, 1922 - Method of Extensive Survey.

METHODS OF KEEPING CONTROL DATA.

By

F. P. Keen.

On a modern control project, the entomologist is called upon to do something more than outline the methods of killing the beetle. He is expected to be the chief engineer if not in a fully directing capacity at least in a consulting one. He is supposed to know how much timber a crew can treat in a day under given conditions, how many men it will take to work a certain area, how far apart the camps should be placed, what is the best camp equipment for the particular style of camp; how many saws, axes, sauce pans and teaspoons will it take; how many spotters will be needed and hundreds of other questions of a practical nature.

I must confess that when I found that I was to act as the supervising entomologist on the Southern Oregon-Northern California Project and tried to round up the necessary information that I knew I would be called upon to deliver, I was very much discouraged to find that nothing had ever been written up on the subject of how to run a control project and what to do when you get there. It was a case of starting in on the ground floor.

On account of the mixed ownership in the Southern Oregon-Northern Calif. Project and the method of cost apportionment, it was necessary that very full records of the trees treated, their location, etc. be kept. From our standpoint this was very fortunate that this had to be done, since it gave us a chance to get an immense amount of data that will be of great benefit for future work.

The Records:

A system of records was devised by the writer to take care of the needs of this project, using the good points from other systems which had been used in the past. It is interesting to note that although the system to start with was purely theoretical, it has worked out very well in practice and not a single important change has had to be made. This means that through the life of this project the records from first to last will be uniform.

The system is as follows:

The spotting crew carry into the field just three forms:

(1) Tree data card
(2) Spotting record
(3) Section plat.

The tree data cards are numbered serially and are carried by the spotters; when an infested tree is spotted, it is blazed on three sides, numbered with the serial number of the card, the front side of the card filled out and the card tacked to the tree in a manila envelope. The tree is then entered on the spotting record which is simply a list of the trees spotted.

The compass man carries the section plat, runs the line with compass and pacing and enters the trees with their number in the proper location when the tree is located by the spotter.

At camp the compassman makes copies of his section plat on the larger 8" to the mile scale, showing the location of the trees. This is given to the treating crew as a guide in locating the trees.

When the crew finds an infested tree tagged by the spotter, they treat it and the crew foreman fills out the data on the back of the card and brings it into camp as a record of his day's work.

At night, the cards brought in are checked up as to their location, ownership of the land and volume and are entered in the treated tree record, one sheet being used for each crew.

At the end of the week the treated tree records and spotting records are summarized on the weekly progress report and the treated tree record and weekly progress report sent in to the main office.

The 1" to the mile township form is used to record the progress of the treating work. As sections or forties are spotted they are colored in on the maps with horizontal diagonal lines, and when the section or forty is completely treated the map is colored in solid. This is a convenient method of keeping track of the acreage treated.

The system may at first seem complicated but is quickly understood in the field and the workmen seem to have no difficulty with it. It is surprising how quickly the ordinary laborer will develop so that with the aid of a field map he can find the infested trees without loss of time. Provided, however, they have been accurately mapped by the compassman. Nothing is more expensive than an inaccurate compassman. If the trees are inaccuretely mapped the treating crew soon get disgusted in their search for them and are disposed to do nothing for the rest of the day.

ECONOMIES IN CONTROL MANAGEMENT

By

F. P. Keen.

Economies in Spotting:

The spotting on the Southern Oregon-Northern California project has probably been carried on more inteisively than on any previous project. This has been necessary because of the generally flat country which could only be worked by taking strips back and forth through the sections and because of the need of accurately locating the trees by legal subdivisions.

One, two and three and four man spotting crews were used but it is the conclusion of the writer that for general work on this project the three man crew, consisting of 1 compassman and two spotters is the most efficient.

Mr. Harvey Abbey was a "one man spotting crew" at Camp 35 during the fall work and did the spotting for nine laborers. He was an exceptionally capable man along this line however, and was thoroughly familiar with the county in which he was working. In general, one man if very capable can do the spotting for a small crew.

Two men, one compassman and one spotter, will not cover much more country in a day than will one man working alone, and still you have the extra cost of an additional man. With both one and two man crews where they feel that they must cover a lot of country in order to keep up with treating crews, the tendency is to be less thorough and lots of trees are not visited and are consequently missed.

With a three man crew each spotter has plenty of time to thoroughly inspect all of his territory within the five chain strip and if necessary to visit every sickly tree. With a good conscientious crew the percent of trees missed is very low indeed.

Diagram No. 1 gives the per day spotting averages for 1, 2, and 3 man spotting crews in various places of infestation. It will be noticed that below 40 trees per section a 1 and 2 man crew can do almost as much as a three man crew while for infestation above 40 trees per section the output of the 3 man crew is very much in excess of the others.

Diagram No. 2 shows the general or average cost of spotting work with varying intensities of infestation, ignoring all other factors such as the character of the undergrowth, topography and the individual efficiencies of the spotters. It will be noticed that the cost per M. of the spotting work increases very rapidly when the intensity of the infestation is less than 30 trees per section.

It will also be noticed that while a 2 man crew is the cheaper for infestations up to 70 trees per section the three man crew is more economical after that point. However, the difference is not great and because of the greater efficiency the reliability of the there man crew it is recommended for any

infestation oaveraging over 50 trees per section where 12 or more laborers are to be supplied with trees.

Economies in Treating:

There has always been considerable difference of opinion as to the relative efficiencies of two and three man treating crews. Diagram 3 illustrates the relative production of these crews under varying camp conditions. It can be easily seen that there are other factors which effect the efficiency to a greater extent than the size of the crew, for instance the need of building fire lines or not. It is impossible to say just how much of the saving is chargeable to the efficiency of the crew and how much to the saving in not building fire lines.

Diagram 4 shows the cost of treating for various styles of camps.

In general it can be said that the two man crew is the more efficient provided fire lines do not have to be built but where fire lines are necessary the three man crew is preferable.

Minimum Diameters:

It is realized that there is a limit to the small sized trees which can be treated with profit. Just what is this limit is no one has as yet been able to definitely say. By platting the actual man minutes for treating time, without even considering the walking time incident to traveling to these small trees, the curve in Diagram 5 was arrived at. The cost per man minute was determined and from this came Diagram 6 showing the cost per M of the treating the various sized trees. It is readily seen that the treating of any tree containing less than 200 B. F. is a very expensive proposition; and that treating trees averaging less than 800 B. F. will cost over $4.25 per M. and will not show a saving in the first year's work as will be explained later.

This shows that it will cost $9.00 per M. to treat a 16", 3 log tree, a 20", 2 log tree or a 26", 1 log tree. However, since such trees often have pretty husky broods of beetles, the cost of the treating is not always the determining factor, but rather the number of beetles that will be killed. In marking for treatment anything less than the diameter mentioned above the spotter must ust his judgment as to the character and abundance of the brood. In general it will not pay to mark anything smaller than a 14" tree.

Maximum Allowance Costs:

In considering the feasibility of control operations, it is not enough to be able to say that the infestation may be reduced if the owner will do certain work, but we must also consider if it is profitable? When will the timber saved be offset by the cost of the work? This is a point which has been given only slight consideration in the past, but I hope through the experience on the

Southern Oregon-Northern California project to add very materially to our knowledge on this subject. From the results so far I have been able to draw up some diagrams which throw a good deal of light on what may be expected.

Diagram 7 is purely a mathematical diagram, the only assumption being that the overwintering generation is $\frac{1}{2}$ of the annual loss and that by treating this generation either in the fall or spring a reduction can be secured in the annual loss of the following year.

To illustrate its use: The preliminary cruises on the Southern Oregon-Northern California project have shown that we have secured a 72% reduction following the spring work. If the timber is worth $3.00 per M. then we cannot afford to spend over $4.25 per M. and have any profit in the first year over the cost of control.

Minimum Intensity of Infestation Profitable to Control:

It is probably vaguely realized by us all that the more scattered the infested timber the more it costs to do control work. But when with diminishing intensity of infestation do we reach the point where the timber saved is offset by the additional cost of the work. I doubt if any of us could offhand give more than a wild guess.

From the records on the Southern Oregon-Northern California Project which on account of the large scale of the operations are already quite voluminous, I have drawn up diagrams which show the spotting and treating production on various intensities of infestation and from these data the corresponding cost of the operations on the various sections, for the different camps and size of crews.

From these figures we arrive at Diagram No. 8 which shows the range of costs per section from the most expensive operations to the cheapest. The preliminary cruise of this fall show that 72% reduction was secured following the spring work; using this as a basis to determine the amount of timber saved per section we secured the second line in the diagram. The points where this line crosses the cost line are the places where the cost of the work and the saving of this year equal. Thus on Area 2 spring work anything less than a 52 tree to the section infestation cost more to treat than the timber saved this year. Area 1 spring work showed a profit down to a 30 tree to the section infestation. This figure can be considered the average. Area 3 fall work on account of the higher production at a low cost, will show a profit down to a 20 tree to the section infestation if the same 72% reduction is secured.

Another point which is not taken into account in this diagram, is the fact that in control work on low infestation only a small reduction is secured. The curve of value of the timber named in the present diagram is more or less theoretical. When this curve is built up from actual field data following next seasons, next summer's survey, it will probably show that anything less than 35 trees to the section was not profitable to work.

The evidence brought out in this diagram will be used in making the recommendations on the Southern Oregon-Northern California project. No work will be recommended in units averaging less than 30 trees per section as long as there are plenty of units averaging 120 trees. Perhaps, later with more evidence at our disposal we will determine in what way maintenance control can be profitably used and what is the best proceedure with infestations of low intensity.

Camp Organization:

The most economic size of camp is a point which has to be determined by the entomologist. On this matter I wish merely to make a few suggestions.

The size of camp should be determined primarily to fit the intensity of the infestation on the area and the number of camps are determined by the size of the area and the length of the working period. For example the infestation on a given unit averages 80 trees per section. From the table of what the spotters can do we see that his will call for a three man spotting crew.

Three spotters will cover ½ section per day and therefore will mark up 40 trees. From the production table of laborers we see that on an 80 tree infestation a three man crew will average 2.6 trees per man per day which will require therefore 15 laborers to treat the 40 trees that the spotters will mark each day. Besides the laborers and spotters there will be needed one superintendent, 1 cook and one helper and one saw filer, or in all a 22 man camp.

If the area to be treated comprises 50 sections with a working period available of 50 days, it will require 2 camps treating ½ section a day apiece to cover the area.

This, in general, is the method of determining the size of the camp organization.

Because of the general average of the infestation on the Southern Oregon-Northern California project runs about 50 trees per section, an 18 man camp has been established as the standard. Thus three spotters will mark 25 trees per day which with an average of 2.1 trees per day will require 12 laborers, 1 superintendent, 1 cook and 1 helper.

Just as a matter of reference there is appended lists of equipment for this standard 18 man camp and the grub rations for one week.

KITCHEN EQUIPMENT FOR EACH CAMP.

6 - Brushes, china pot
1 - Brush, meat block
2 - Brushes, scrub
1 - Broom
2 - Can openers
1 - Chopper, Universal.
1 - Cleaver
1 - Cork screw
2 - Dippers
1 - Doughnut cutter
1 - Egg whip
1 - Flour sifter
1 - Kitchen fork
1 - Funnel, small
1 - " large
2 - Gem tins
1 - Grater
2 - Knives, butcher
2 - Knives, paring
1 - Ladel, strainer
1 - Ladel, skimmer
1 - " deep solid
½ - Bolt oil cloth
1 - Pancake turner
1 - Pan, fry 12"
1 - " " 10"
2 - Pans, Dish 14 qt.
2 - Pan, " 17 "
3 - Pans, milk
1 - Pan, drip large
2 - Pans, " small
1 - Pan, sauce 4½ qt.
1 - " sauce 8 "
1 - Pot " 12 "
4 - Pails, 14 qt.
4 - Pie tins, shallow
4 - Pie tins, deep
1 - Potato masher.

1 - Pot, coffee 3 gal.
1 - " , tea 2 "
1 - Rolling Pine
1 - Range
1 - Set range pipe
1 - Strainer, china cap
1 - " tea
1 - Saw, Meat with two blades
1 - Spoon, stirring
1 - Steel, butcher
1 - Scoop, Baker
2 - Sheets, cookey
1 - Rool Screen

OFFICE SUPPLIES

2 - Blotters
2 - Pens
1 - Bottle Ink.
1 - Dz. 4H pencils
1 - " Erasers
1 - Box Carbon paper
50 - Sheets 874-13, diary.
100 - Time Sheets
2 - Volume Tables
1 - Book section forms (Compassman)
2 - Maps of area ($\frac{1}{2}$" to mile)
1 - Oenership map
1 - Triplicating order book
60 - Spotting records
1 - Pad treated tree record forms
10 - Weekly progress reports
1 - Pad section plats (8" to mile)
500 - Tree record cards
500 - Envelopes
1 - Dz. black timber crayons
1 - Tape measure
1 - Box for records
12 - Township Plats - 1" to mile (Progress maps)

SOUTHERN OREGON-NORTHERN CALIFORNIA
PINE BEETLE CONTROL PROJECT
1922

Standard "Grub" Rations for 20 Men for Seven Days as Used in Pine Beetle Control Camps.

Meat Products	
Bacon	10 Lbs.
Beef	77 "
Ham	27 "
Lard	10 "
Mutton	2 "
Pork	3 "
Salmon #2	1½ cns.
Diary Products	
Butter	12 Lbs.
Cheese	5 "
Eggs	23 Dz.
Milk, Talls	54 Cns.
Sugar, White	57 Lbs.
Grain Products	
Bread	
Cornmeal	2 Lbs.
Crackers	1½ "
Flour, Graham	1½ "
Flour, White	88 "
Macaroni	2½ "
Noodles	
Rice	3 "
Rolled Oats	5½ "
Wheat hearts	
Middlings	1 "
Fresh Fruits and Vegetables	
Onions	8½ Lbs.
Potatoes	74 "
Carrots	5 "
Cabbage	8 "
Parsnips	4½ "
Beets	1 "
Rhubarb	3
Spinnach	2 "

Canned Fruits and Vegetables.		
Beans		
Beans, string	#2	2 cns.
Corn	#2	4 "
Hominy	#2½	1½ "
Peaches	#10	
Peas	#2	4 "
Pears	#10	
Pineapple	#10	
Pumpkin	#10	1 "
Tomatoes	#10	2 "

All Other Foods.	
Allspice	
Applebutter #10	½ cns.
Baking Pwd.	1-2/3 Lbs.
Baking Soda	¼ Pk.
Catsup	1 Gal.
Chocolate	2 Lbs.
Cinnamon	1 Oz.
Cocoanut	½ Lb.
Coffee	6 "
Cornstarch	1 "
Extract, Lemon	1½ Oz.
Extract, Vanilla	1¾ "
Ginger	2 "
Mapeline	½ "
Molasses #2½	½ Cn.
Mustard	2 Oz.
Nutmeg	3 "
Pepper, black	3 "
Pepper, red	1½ "
Picklews	2 Qt.
Sage	1 Oz.
Salt	5 Lb.
Tapioca	1 "
Tea	2/3 "
Vinegar	1 Qt.
Yeast, Magic	2½ Pk.

Dried Fruits and Vegetables

Apples	4½ Lbs.
Beans, Bayo	3½ "
Beans, white	4 "
Peaches	6 "
Prunes	6 "
Raisins	6 "

Sundry Supplies

Lime, Chloride	½ Cn.
Matches	5 Bxs.
Oil, Elaine	1-2/3 Gal.
Soap, laundry	5 Brs.
Soap, hand	3 "
Soap, powder	1 Pkg.
Wessen Oil	1 Pt.

SOUTHERN OREGON-NORTHERN CALIFORNIA
PINE BEETLE CONTROL PROJECT
1922

Camp Equipment for One Camp.
18 Men
6 - 2 man falling crews
3 - Spotters, compassman
1 - Foreman
1 - Cook
1 - Helper

1 - Alarm Clock
2 - Aluminum loose sheet holders 4" x 8½"
1 - Axe, marking, straight handle
12 - Axes, D.B. Young pattern 3½# handled
8 - Axes " " " 3¾# "
10 - Axe handles, 36" oval
6 - Canteens, 1 Gal.
2 - " Army, 1 qt. with carrier strap
3 - Carrier sacks, canvas.
6 - Carborundum stones #196
18 - Cots folding iron
2 - Compass and staff
1 - 874-c Cover
12 - Files nicholson 8" flat mill bast
1 - First Aid Kit
1 - Grinder
1 - Hammer, claw
1 - Hammer saw set
6 - Lanterns #2 burner
18 - Mattresses
5# - Nails, assorted
1 - Pick Mattock
6 - Rakes
1 - Saw, hand crosscut
8 - Saws, 6½' falling
6 - Pr. Saw handles
1- Saw tool
6 - Shovels
3 - Sibley Stoves
3 - Sibley stovepipe sets
6 - Sledges
6 - Sledge handles
2 - Tally registers
1# - Tacks

1 - Tape, Diameter
3 - Tents, 16' x 16'
1 - Tent, 16' x 20'
1 - Tent stovepipe tin
6 - Wash Basins
2 - Wash tubs
2 - Wash boards
10 - Falling Wedges, 4-#4, 4-#5, 2-#6

TABLE EQUIPMENT FOR EACH CAMP.

4 -	Bowls, 4 qt.
4 -	" 3 "
20 -	" Soup
2 -	" Sugar
32 -	Cups
24 -	Forks
24 -	Knives
4 -	Pitchers, Syrup
2 -	" Water
25 -	Plates
2 -	Pots, Coffee 4 qt.
2 -	Pots, tea 2 "
20 -	Saucers
36 -	Spoons, tea
36 -	" table
3 -	Shakers, salt
3 -	" pepper
6 -	Yd. White duck.

PROF. ESSIG: Interested regarding cost. Why can you only afford to treat 20-40 per sec.? Could not a slight infestation be controlled at a less cost?

MR KEEN: Hope to go in before they reach epidemic. After epidemic the factor of reduction comes in. This phase is the factor of reduction on dollars and cents. Higher intensity greater reduction - lower intensity, less reduction.

MR MILLER: My idea eventually is to carry on the maintenance control. The cost was 45 cents per acre in the experiment on the San Joaquin epidemic (Keen's) cost 45¢ per acre. Bringing down an endemic will cost less than Keen's year after year control.

PROF. METCALF. Do you treat trees above 12" in diameter or 200 bd. ft.

KEEN: Only in groups, keep to larger trees. Cannot attempt a 100%. control, refers to Dr. Hopkins' percentage principle, get out higher percentage. Camp organization and size of camp cruises covering 1/2 section per day determines size of camp, most efficient with 18 man crew. Not efficient to cover more than 1/2 section per day. Camp to fit area.

EDMONSTON: Tried cruising and spotting.

MR KEEN: Several difficulties cutting crews have to run compass maps, etc.

MR EDMONSTON: Keep.

MR KEEN: Certain amount of time in spotting and cutting will spend most of their time spotting. Maximum efficiency obtained by

MR EDMONSTON: One man in charge?

MR KEEN: Foreman keeps track of mens work, regard, checking upon them soon know of crew.

MR KEEN: A fairly constant number always present; larger trees contained large brood of brevicomis.

MR KEEN: Forms printed for project. Explained spotting system, "Bug" chain. Compassman most important spotter. Camp organization, number of trees treated, ownership, <u>intensive survey</u>?

MR MILLER: Figure on carrying on San Joaquin project for several years no results definite, like to ask regarding the treating. Topographic methods using compass only to be in. One man crew best in Sierra from prominent point at cost 40¢ per tree - about 20¢ per M. 1-1/10 sec. per day, 88,000 acres, 14

trees per section at 15 trees per day cost $5.50 per sec. Comparison in cost favors topography.

MR EDMONSTON: Regarding volume measurement.

MR KEEN: Will use tape; biltmore was consistently overestimated. Treating crews measure length.

MR PERSON: Regarding the two spotting methods believe efficient factor to be considered fall trees late in showing up.

SUMMARY OF PAPERS ON CONTROL PROJECTS.

1. History of Forest Insect Depredations and Control.
   Control in the West started over 20 years ago thru the initiative of Dr. A. D. Hopkins, who determined that:

   (a) Insects were taking an enormous toll of good quality timber.
   (b) Part of loss could be prevented at a justifiable cost.

   In the West, three species of Dendroctonus beetles are the most important:

   1. Black Hills Beetle (D. ponderosae)
      Which kills yellow pine thru the Rocky Mt. Region.
      Black Hills infestation from 1897 to 1903 killed one billion feet of timber.

   2. Western Pine Beetle (D. brevicomis)
      Kills yellow pine in California, Oregon, Washington, Idaho and Montana.
      In Southern Oregon has killed over one billion feet in dacade 1911-1920

   3. Mountain Pine Beetle (D. monticolae)
      Kills many species of pine thruout Pacific Coast and Northern Rocky Mt. Region.
      Thousands of acres of lodgepole have been wiped out by this beetle. Bark Beetle problems in west largely confined to pine. Investigations of Bureau have shown that control work pays. These methods are now becoming more generally adopted.
      The fight against barkbeetles entering an era of rapid expansion.

History of Forest Insect Depredations of the West.

and What has been Done to Control Them.

By

A. J. Jaenicke.

The development of forest insect control in the west began over twenty years ago largely through the initiative of Dr. A. D. Hopkins of the Bureau of Entomology who brought to the attention of those responsible for the protection of government and private forest resources: first, that insects were taking an enormous toll of good quality timber in the Rocky Mountain region and Pacific Coast region and, secondly, that a part of this loss could be prevented through certain measures the cost of which would be well justified.

Since that time there has been an ever growing interest in the control of insect depredations in the western forests, and a gratifying increase in the knowledge of how best to control these losses and to prevent their recurrence. That insect control has as legitimate a place in forest management as fire protection is generally recognized by both private and government agencies.

Yellow pine, western white pine, sugar pine and lodgepole pine. This beetle is active in the northern Rocky Mountain and Pacific Coast Regions. It is a menace of special importance in the white pine stands of Idaho and in the sugar pine forests of California. In Idaho as much as one or two per cent of the white pine is some times killed each year for several years in the epidemic infestations. In the sugar pine of California a loss of one per cent per annum for three or four years is not infrequent. In the Northern Rocky Mountain and Pacific Coast regions the entire stand of lodgepole has in frequent instances been practically wiped out on thousands of acres because of the ravages of the mountain pine beetle. These extensive killings in lodgepole constitute fire hazards of the worst sort.

It is evident that the bark beetle problems in the West are largely confined to various species of pines. Barkbeetles are active in the various other genera of conifers and in hardwoods as well but ordinarily their work is not comparable in importance to their activity in the pines mentioned in the preceding paragraphs.

When forest protection developed in a large scale on private and government lands, evidences of past and present beetle epidemics were noticed frequently and gradually as timber has become of greater and greater value, the protection of the forests against the recurrence of these epidemics has been a more insistent need. It became necessary to study the habits of these beetles and from the knowledge of their habits to develop methods of control. It is for this research that the federal Bureau of Entomology has maintained forest insect stations in various portions of the Rocky Mountains and Pacific Coast regions. There are still many insect control problems which are far from solution but yet enough progress has been made to justify the adoption on a wide scale of the control methods which have been developed and to give reasonable assurance that the use of these control methods will result in the checking of epidemic losses at a cost which will pay dividends in the form of the quantity of timber saved. These control methods have already been put to test. Thus far the Forest Service and the Park Service have, under the advice of the Bureau of Entomology, done most of this work but during the past five years private owners of timber have become convinced of the desirability of such measures and now they are undertaking to curb the epidemics in their holdings with the cooperation of the Federal Government. It is estimated that during the past ten years over $100,000 has been spent on control work in Oregon, a similar amount in California and perhaps in the Rocky Mountain region $50,000 has been spent.

The fight against bark beetles in the forests of the West is now at the beginning of an era of rapid expansion in which the various government and private agencies bid fair to render each other the most helpful cooperation.

MR PRATT: I would like to ask what the Oregon Pine Beetle Law is, and how it works out and what relation has the State Forester to its execution.

MR KEEN: The state law of Oregon provides that when the owners of 60% of the timberland request that control work be done the state forester declares a zone of infestation and then it devolves upon the owners, after they have been given notice and within thirty days, to clean up. On the Southern Oregon Project 63% of the owners made application to the State Forester to declare such a zone and within a short time thereafter the State Forester issued notices demanding that the owners abate the nuisance and take proper steps to eradicate the beetles either through their own efforts or through affiliation with the Protective Association, which was made the State Forester's representative on the ground. As far as the State Forester's office is concerned, that is about as far as they had to go this year except to check up on the applications that were made to see that they amounted to 80% or more of the owners and that they were the legal owners of the property.

The state law further calls upon the State Forester if the work is not done by the private land owners to go upon the land and to do the control work and assess the owners on an actual cost basis. If they do not pay at the first request, these costs are put upon a county lien docket and assessed in that way.

On the Southern Oregon Project, the costs have just been worked up and it amounted to about 10% of the total of involuntary owners and so far they have not been called upon to pay for it.

MR PRATT: Who did that?

MR KEEN: The Board of Control's office worked all of that data up. These have all been turned over to the State Forester with the request than an audit of the books be made and a statement sent to the owners.

MR PRATT: As you probably know, a bill has been introduced in the Senate by Mr. Ingraham, which is identical with the Oregon law. I think that bill will go through.

B. History and Review of Past Control Projects in Colorado.

By
W. D. Edmonston.

1. Early Rocky Mountain Projects:

The primary insect involved in all Colorado Control Projects was *D. ponderosae*.

In the Pine National Forest and adjacent private lands infestation in yellow pine of an epidemic character was first observed in December 1904, at Palmer Lake on the Arkansas Platte Divide, and on private and national forest lands in the vicinity of Colorado Springs. The latter, was reported in August 1905, and during 1905 and 1906.

Dr. Hopkins visited the areas in the fall of 1905 and again in the spring of 1906, He recommended the cutting and peeling of the infested trees; 509 trees were treated at Palmer Lake and over 1200 trees on National Forest and Private lands west of Colorado Springs. This resulted in reducing the epidemic to a point very much below what we now term endemic. As much of the timber could be utilized the cost of the operation was small.

On the Trinchera estate, a private holding in Southern Colorado, which Dr. Hopkins visited in the spring of 1906, and through the efforts of the owners, succeeded in having 500 infested trees cut and barked within the necessary period to destroy the broods. This operation proved successful. I examined the area in 1908 and again in 1915, and could not locate an infested tree.

On the Los Animas National Forest in Southern Colorado (this forest is now a part of the San Isabel National Forest) I located an infestation that had passed the endemic stage. It has been in progress and must have been more or less conspicuous for six to eight years. Timber sales disposed of much of the infestation, but in addition the Forest Service under the advice of the Bureau, cut and barked 165 infested trees in May and June, 1908. The total cost was $177.50 or a little over $1.00 per tree.

In July 1909, accompanied by the Forest Supervisor I made a very thorough examination of the area, about 17,000 acres, as well as most of the forest. Outside of an occasional infested tree which you can nearly always find, if you hunt long enough, I could find no new infestation.

In 1915, Entomological Ranger, Hofer and I examined the area and we could find no infestation.

The Wet Mountains Division of the San Isabel National Forest.

This was a heavy, concentrated infestation on two small areas, ten miles apart, with more or less scattered or endemic infestation between and on surrounding areas. Ranger Theo. Shoemaker in September 1908, reported the infestation. It was based on the Red-top trees. In December 1908 I was ordered to locate and mark the infested trees. On February 8, 1909, I submitted my report and on the 19th Dr. Hopkins submitted recommendations through the Forester to the Supervisor, with a copy of my report. On March 6th, $200 was set aside by the Forester for insect control work on this forest. Two chief centers of infestation were located, and the policy of control was to concentrate the cutting to the larger clumps. The total loss on the two areas of centralized infestation was 1,325 trees of which

number 1,070 were treated, or 80%. The cost, exclusive of Rangers' salaries, and which is properly chargeable to the expense of the actual control work, was $400.00. The cost per tree was about .50¢.

On August 5, 1909, Ranger Shoemaker, who had had charge of the work made a careful examination of the infested area, and failed to discover any new attack. In his report dated September 1, 1909, he states, -"Not a single tree with pitch tubes was found, except what were attacked without success last year, and no new work appears on them."

In September 1909, I examined the areas and found 9 infested trees, evidently attacked since Shoemaker's examination.

On November 7th, No new infestation was noted.

The area ten miles south, where we cut 160 trees, show only slight endemic infestation. We could not get action on this area on account of intervening patented lands, and other unsurmountable difficulties.

In 1915, and 1922 the areas were again examined. The northern areas were still clear of infestation; the southern areas have still a lot of endemic infestation, mostly on private lands.

The Evans Estate near the Pike National Forest.

Another infestation by the Black Hills beetle in a dense stand of mature western yellow pine on the Bear Creek watershed, in north-central Colorado, near Idaho Springs, involving more than 1,000 infested and dying trees, was located in the spring of 1907, by Ranger Edmonston, detailed to this Bureau. The depredations had been going on for the past ten or fifteen years or more, which had resulted in the death of 800,000 feet board measure, of the finest timber. About 65,000 feet board measure was found to be infested at that time. No action was taken by the owner, although notified by this bureau of the dangerous character of the invasion, and the required action to control it recommended. In the fall of 1907, Edmonston made another examination of the property, when it was found that the new infestation, resulting from swarms of beetles that had been allowed to emerge from the old infested trees, involved nearly four times as much timber, or 240,000 feet board measure. This alarming increase led to the prompt adoption of the recommendations by the owner and the Forest Service, and by May 1908, the small number of trees on the National Forest and the 1,000 infested trees on the private estates were felled. The latter were accessible for utilization and by May of 1908 the infestation was controlled by converting the infested timber into lumber and burning the slabs.

On December 1, 1908, Edmonston reported only three newly infested trees, which were isolated individuals. In 1915 Hofer and Edmonston examined the area and found no infestation of any importance, not even endemic.

White River National Forest Insect Control Project.

The area was on the south Derby Mesa, near Burns Colorado, 2500 acres with an estimated pure stand of yellow pine of 2,500,000 feet B.m. In January 1908 I found the loss for the past four years amounted to 250,000 feet, or 3,200 trees, actual count. I marked 260 infested trees. These were not cut.

The ranger in charge of the district reported the marked trees had all died. In 1909, a like number were infested and they died. In April 1910, I marked 129 trees. These were cut and the bark burned on the trunks, the work being done by forest rangers. The area was examined in the fall of 1915 by Hofer and myself. We found eight trees had been killed in 1913, 13 in 1914, and in 1915 we found five infested trees on this area.

1. Kaibab-Grand Canyon Insect Control Project. 1921- 1922

2. Dendroctonus ponderosae Hopk.

3. Kaibab National Forest and Grand Canyon National Park, Arizona. North Rim of Grand Canyon, see attached map.

4. Approximate area Nat. Forest: 1,072,900 Acres; 400,000 acres timbered. Approximate area Nat. Park: 55,000 acres timbered. North Rim area. All timber owned by U. S.

5. Two billion feet, 80% of which is yellow pine; One billion feet is merchantable; other types consist of Blue spruce and Englemann, Douglas fir, White fir and Sub-Alpine fir; Juniper and Pinyon on the border of the forest at a lower elevation. Timber is accessible but is 200 miles from nearest railroad on the north in Utah. Value of timber not known.

6. Losses previous to control work cannot even be approximated; the insect killed timber is not evenly distributed but is centered in clumps of two trees up to 350 trees in a clump all through the zone of infestation which is estimated at 80,000 acres; every dead tree in every clump would have to be counted, placed in its class year and then we have no estimate of the merchantable living timber on the area.

7. Tentative agreement covering preliminary field work 1921 between District and local forest officers Dis. 4; Nat. Park Super., W. D. Edmonston for Div. Forest Insects. Subsequent cooperation agreement covering control project; Forester; Director Nat. Park Service; Chief Bureau Entomology. 1922 final agreement and division on working plans and methods, responsibility for carrying on the project as a whole: Dr. A. D. Hopkins and Mr. E. E. Carter. Delegated authority and Division of field work: District 4 and local forest officers; Edmonston and Hofer, Southern Rocky Mt. Forest Insect Station. Administrative Supervision of the work rested with the Forest Service, i.e., Dist. 4, 6, B. Morse, John C. Roak, Forest Supervisor, "Kaibab". Supervision under a percentage principle of control and the entomological requirements of the work, when to start and when to stop; the location and marking of the infested trees and treatment; Division of Forest Insects, Edmonston and Hofer.
Work was concentrated on heaviest centers of infestation; transportation by teams and wagons, automobile, and auto truck park time.
Two camps consisting of five three men crews, foreman, cook, flunkey and teamster a total of 19 men per camp or 38 men in all.
Supersivion: Forest Supervisor and Chief of Management; Edmonston & Hofer.

8. Operating period: May 15 to July 14, 1922.
Number of trees treated: 5,683
Volume treated: 1,800,000
Acreage Covered: Nat. Forest 14,440, Nat. Park, 2,560, total 17,000.
The 17,000 acres represents twelve camp areas or units on which trees were cut and treated. Actual area or zone of infestation approximated 80,000 acres or 1/5 of the timbered area of the Park and Forest.

Acreage Protected: Result of work not known.
Man Days: Will have to be computed from Forest Service records.

9. Cost: Total cost, $8,965.39. Taken from reports of Forest Supervisor; (segregation of costs is so arranged that accurate divisions of operating costs can not be arrived at.)
Cost per tree: $1.57.
Cost per thousand board feet: $4.48. Based on two million feet.
Cost per acre treated : Approx. .52¢
Cost per acre protected: Result of work not known.
Cost per man day: No information.

10. Results: No information

THE CHAIRMAN: Mr. Burke, do you wish to present your data on the Black Hills?

MR. BURKE: The Black Hills timber was very valuable and there was a great demand for that wood, not because the tree was particularly valuable, but because of the fact that the Black Hills is isolated and there is great demand for that timber in the mines. Probably most of it went to the mines, although some lumber was shipped out. I don't know where the recommendation same from but someone got the idea that here was a good chance to get rid of the timber and many contracts were let, for the beetle killed timber. The timber was cut and sold at lower rates because it was beetle killed. There had been large sales and in 1902, or 1901, Dr. Hopkins went in there and he was asked to look over carefully to see how the logging control was going and look over the men doing the cutting. Dr. Hopkins found out that half of the timber that was cut was beetle killed and the other half was green. There was no way of finding out how much of the timber that was sold was insect killed. The epidemic started in the northern part of the hills; the Hills are sixty miles wide and over 100 miles long; and traveled south. In ten years it had reached the southern end of the timber and stopped. Along about 1906 or 1907, before the end of the epidemic, the forest service and the Bureau did some control work. In 1908 the forest service, under Forest Assistant, Neals, cut 278 trees. These were cut and barked and the total cost of each tree was .81¢ and the cost per thousand feet, $5.49. In 1905 a total of 2778 were cut; no average diameter of these trees was given, but the Black Hills trees won't average over 30". Probably I should give the labor cost too. The cost per hour by the day was .25¢ an hour, the cost per tree averaging .81¢; the cost per thousand feet $5.49. The year before there had been a bark peeling tool invented. You probably remember those; it could be adjusted to handle the different sized trees. The total number of these trees were 349, all of them were treated and the cost of peeling the trees was .27¢. According to Webb's report made in 1906, two men peeled 105 trees in six days; the trees varied in diameter from 6" to 2 ft. The total number of board feet cut was 382,824, at a cost of $2546.00, or an average of $8.97 per thousand feet. So far as I know that was the only control work done in the Black Hills.

MR KEEN: I didn't understand the cost per thousand.

MR BURKE: I guess that was $8.00. There is no question but what onethird of the timber was killed. The latest Forest Service Report that I remember was 1,000,000 feet of timber was killed.

MR EDMONSTON: In regard to the Parker Station Control Work, I believe the last report we had from this showed it was cleaner than any other part of that whole locality in there. One section I saw had sixteen million feet to the section. Where we cut, I think 260 trees. I don't remember the scale. Very little brevicomis infestations followed our work. Then I think it was examined afterwards and found to be in very good shape. Hopkins thought the money expended, how much I do not know, was justified. He seemed to be satisfied.

MR KEEN: I would like to add that the control work has been done throughout this project area by Mr. Kimball's organization from time to time. His work, however, I think has been sporadic and scattered more or less, in little localities here and there. It is questionable whether there has been any lasting results from his efforts. I think Mr. Kimball himself realizes his efforts have been futile in regard to this. For those who are not familiar I would like to say the infestation in 1918 in certain centers ran as high as 400 trees to the section. At the present time thru certain parts of the yellow pine belt on Area 1 we have an average of about eighty trees to the section, while the other areas where we are working average infestations around 120 trees to the section. Some of the area is what we are calling endemic or about thirty trees to the section. Anything over thirty we are considering epidemic.

RESULTS OF NORTHEASTERN OREGON PROJECT.

	Acreage	Infestation 1910-11 Treated Y.P.	Missed (Redtops)	Total	Infestation 1911-1912 Y.P.	% Treated	% Reduced
Anthony Creek Camp #2	2320	323	130	453	255	71%	43%
Big Gulch Camp #5	3500	93	114	207	110	45%	47%
Bulger Flat Camp #2	3360	428	304	732	236	58.5%	68%
North Powder River Camp #5	2040	1610	34	1644	422	98%	74.5%
Muddy Creek Camp #5	3280	632	24	656	337	97%	48.5%
Pine Creek Camp #2	1920	78	0	78	No data		
Marble Creek Camp #2	2560	829	29	858	44	96.5%	95%
Hibbard Gulch Camp #2	1920	997	23	1020	40	98%	96%
Elk Creek Camp #1	5960	2793	28	2821	29	99%	99%
Poker Creek Camp #1	4430	1031	27	1058	241	97.5%	77%
Union Creek Camp #4	3420	299	112	411	371	73%	10%
Miners Creek No. 1	4830	337	73	410	333	82%	19%
Deer Creek No. 1	4370	111	16	127	144	87%	(- 13% increase)
Sheep Creek, Snowball, White Face, Sumpter	10910	409	44	453	69	90%	85%
Slim Creek No. 6	1650	125	22	147	65	85%	56%
Sheep Rock Camp #8	6100	229	52	281	89	81%	68.5%
Cold Spring No. 7.	9560	1889	40	1929	299	98%	84.5%
Total	76430	12219	1072	13291	3083	92%	77%.

RESULTS OF NORTHEASTERN OREGON PROJECT

BY UNITS.

	Acres Treated	Infestation 1910-11 Treated Y.P.(Redtops)	Missed	Total	Infestation 1911-1912 Y.P.	% Treated	% Reduced
Unit 1 Anthony Creek to Elk Creek	21,860	7783	686	8469	1473	92%	82.5%
Unit 2 Deep Creek to Poker Creek	17,050	1778	228	2006	1088	88.5%	46%
Unit 3 Silver Creek to Sumpter	16,860	540	66	606	134	89%	78%
Unit 4 Sheep Rock to Cold Springs	15,660	2118	92	2210	388	96%	82.5%
Grand Total	87,950	14,483	1072	15,555	3083	93%	80%

PARKERS STATION PROJECT - OREGON

Location: T 40 S., R 5E
Sec. 2, 3, 4, 9, 10, 11, 14, 15, 16, 21, 22, 25.
T 39 S., R 5E
Sec. 17, 18, 19, 20, 21, 27, 28, 29, 33, 34, 35.

February 9, 1912. Edmonston Report.
Yellow pine on Section 28, tp. 39 S. R. 5E, WM, Oregon.
(The number of trees given is by actual count and standing trees only)

Number of infested trees			Aver. Diameter	Total in F.B.M.
attack of ----------------	1911	74	22"	135,800
No. of trees ----------------	1910	30	26"	54,000
No. of trees ----------------	1909	41	28"	70,800
No. of trees prior to-------- (Approx. 20 years)	1909	512	23"	900,000
		657		1,160,600

Estimate of live merchantable timber on Sec. 28

Type	Total in F.B.M.		Number of Acres
Yellow and sugar pine	3,888,000		360
Douglas fir	170,000		90
White fir	224,000)		
Incense cedar	100,000)		
		Burns & parks	110
Totals	4,382,000		640

May 25, 1912. Edmonston's Preliminary Report, Parkers Station Project, Klamath County, Oregon.

Description of lands.		Acreage cruised.	No. of insect infested trees cut and treated.	
T 39 S, R 5 E, W. Mer.		Acres	Yellow Pine	Sugar Pine
Section	15	640	2	12
"	16	640	25	
"	20	160	18	
"	22	160	2	
"	26	480	6	
"	27	640	6	
"	28	640	40	
"	29	320	5	
"	33	640	16	
"	34	640	12	
"	36	640	8	
Total		5600	140	14

Mpt

<u>Note</u> 2 trees cut on Sec. 9 close to south line
2 " " " " 17 " " east "
1 " " " " 19 " " " "
3 " " " " 21 " " S&W "
(1 S.P.)2 " " " " 9 on line of Sec. 16
10

T 40 S R 5 E, W. Mer.		Acres	Yellow Pine	Sugar Pine
Section	24	640	23	1
"	25	640	25	
"	26	640	28	
	Totals	1920	76	1

<u>Note</u> 1 tree cut on Sec. 35, close to north line
1 " " " " 13, " " south "
2

T 40 S, R 6 E, W. Mer.				
Section	19	640	24	1
"	30	640	22	1
	Totals	1280	46	2

<u>Note 2 trees on Sec. 6</u>

Total number of yellow pine trees cut and bark burned 282
Average D.B.H. 22-1/2 inches, average height 87 feet, total amount in F. B.M. 440,000.

Total number of sugar pine trees cut and bark removed, 18, average D.B.H. 33 inches, average height 128 feet, total amount in F.B.M. 98,000.

<u>Resume</u>:

Number of acres cruised, 8,800; total number of trees treated 300; total amount of feed board measure 538,000.

June 4, 1912, Edmonston to H.

Parkers Station Project. 1912, 300 trees cut, 538,000 F.B.M. The cost is about $2.50 a tree - accurate figures are not yet available.

June 19, 1913, From annual report of W. D. Edmonston.

As a direct result of the Parkers Station demonstration control project undertaken in the spring of 1912, the Klamath Lake Counties Forest Fire Association continued the control operations extending them to areas a few miles from the treated areas. Six of the association fire patrol men who worked on the Parkers Station project and received a thorough training in the methods of insect control were kept on by the association after the fire season was passed and through October, November and part of December, 1912.

cut and treated half a million feet of insect infested yellow pine and sugar pine, covering 15 sections of land near Keno, Ore. This same crew with additional men cut and treated between April 1, and May 30, 1913, close to 600,000 F.B.M. of infested sugar pine and yellow pine timber, on areas adjacent to those they worked over in the fall. The timber treated was owned by the Ashkosk Lumber Co., Weyerhaeuser Timber Co., Southern Pacific Co., and the Trustees of the Hoplins' Estate.

The Parkers Station Project area was examined at the end of October and part of November. On one unit examined the reduction in the infestation was found to be close to 88%. On the other unit examined in May 1913 the results were still better. The figures, however, have not yet been worked out.

Outline of History of
Southern Oregon - Northern California
Pine Beetle Control Project.

By
F. P. Keen.

1. Name:
Southern Oregon Northern California Pine Beetle Control Project.

2. Primary Insect:
Dendroctonus brevicomis

3. Location:
Jackson, Klamath and Lake Counties, Oregon & Shasta & Modoc County, California. Headquarters at Klamath Falls, Oregon.

4. Acreage involved:

	656,500	acres	Federal lands
	3,800	"	State lands
	586,700	"	Private lands
Total -	1,247,000	"	Timber Lands.

5. Timber resources involved 12,000,000 B.F. valued at over 36 million dollars. Most of the timber is of higher merchantability. Since the area is very large some of it is quite accessible and will not probably be logged for thirty years.

6. Extent of losses:

Year	No. Trees	Volume B.M.	% of Stand.
1918	260,000	236,000,000	2.0
1919	197,000	177,000,000	1.5
1920	126,615	115,668,000	.98
1921	102,393	91,961,000	.78
4 Years	686,008	620,629,000	
Average per year	171,502	155,157,250	1.3%.

7. Organization of Project:

The project was organized as a cooperative federal and private and divided into three areas, one of which was administered by the Klamath Forest Protective Association; one by the Indian Service and one by the Forest Service. The Entomological Supervision and inspection was provided by the Bureau of Entomology on all three areas; the general administration was handled by a Board of Control consisting of a representative of the Forest Service, Indian Service and Klamath Forest Protective Association, the Bureau of Entomology and the Oregon State Forester.

For the work on Federal lands and for the entomological Supervision Congress appropriated $150,000.

During the spring work ten, eighteen man camps were operated for an average period of 34 days with about 200 men on the payroll.

During the summer five camps were operated with 20 men on the payroll and the work was done using the sun curing method.

In the fall five camps were operated with about 75 men on the payroll. Due to the efficiency of the organization and the comparatively favorable working conditions in the fall, the work done at this time was by far the cheapest of the year.

Amount of Timber Treated:

Area One.

Period of Operations	No. Trees Treated	Volume Treated	Acreage Covered	Acreage Protected	Man Days.
Spring	3524	3,354,260	26,450	51,500	2039
Summer	72	103,560	1,681	3,000	85
Fall	533	579,700	4,727	10,000	365
Total	4129	4,037,520	32,858	64,500	2489

Area Two:

Spring	1931	1,710,750	22,640	35,040	1721
Summer	183	209,100	4,960	10,000	304
Fall	1222	1,510,490	18,429	51,860	1285
Total	3336	3,430,340	46,029	96,900	3310

Area Three:

Spring	1790	1,717,730	22,380	50,000	1607
Summer	503	581,970	17,440	28,600	501
Fall	1824	2,308,220	25,440	60,000	1378
Total	4117	4,607,920	65,260	138,600	3486

TOTAL FOR PROJECT.

Entire Year	11,582	12,075,780	144,147	300,000	9285

Average Volume per Tree.		Average No. per Sec.	
Area 1	980 B. F.	80	Infested Trees
" 2	1030 B. F.	46	" "
" 3	1120 B. F.	40	" "

9. Cost:

Total Costs Against Overwintering Generation of 1921.

	Wages	Subsistence	Transportation	Misc.	Total
Spring					
Area 1	7669.62	2054.41	1462.81	1296.46	12,483.30
" 2	6160.60	1755.02	744.25	1132.20	9,822.07
" 3	5356.72	1482.35	1927.18	1230.37	9,996.62
Total	19,186.94	5291.76	4164.24	3659.03	32,301.99

Costs Against Summer Generation of 1922.

	Wages	Subsistence	Transportation	Misc.	Total
Summer					
Area 1	276.16	173.17	45.75	655.09	1,150.17
" 2	1161.01	240.17	198.10	607.88	2,207.16
" 3	2191.66	509.60	219.90	662.05	3,583.21
Total	3628.83	922.94	463.75	1925.02	6,940.54

Costs Against Overwintering Generation of 1922.

	Wages	Subsistence	Transportation	Misc.	Total
Fall Work					
Area 1	1513.35	216.21	243.00	504.25	2,476.81
" 2	4556.13	831.36	515.09	461.31	6,363.89
" 3	4988.25	1166.11	497.81	510.79	7,162.96
Total	11,057.73	2213.68	1255.90	1476.35	16,003.66

Total for the Year.

	Wages	Subsistence	Transportation	Misc.	Total
Area 1	9,459.13	2443.79	1751.56	2455.80	16,110.28
" 2	11,877.74	2826.55	1487.44	2201.39	18,393.12
" 3	12,536.63	3158.06	2644.89	2403.21	20,742.79
Total	33,873.50	8428.40	5883.89	7060.40	55,246.19

From Federal Funds	$33,205.79
From Private Funds	22,040.40
Project.	$55,246.19

Cost Averages	Area 1	Area 2	Area 3	Total
Cost per Tree	3.90	5.51	5.04	4.77
Cost per M.	3.99	5.36	4.50	4.57
Cost per Acre Treated	.49	.40	.32	.38
Cost per acre protected	.25	.19	.15	.18
Cost per Man Day	6.49	5.55	5.95	5.95

10. Results:

From preliminary cruises in the fall of 1922 in the areas worked it appeared that there had been secured a 72% reduction in the infestation, as a result of the spring work.

With a total loss in 1921 of 19,112,390 B. F. in the units worked, this means a saving of 13,750,000 B.F. valued at more than $41,250 or a net saving over the cost of the spring work of $8,822.00. Whatever saving is effected in the following years will be clear profit.

Because of the cheaper fall work, the saving resulting from it will probably be very much greater than from the spring work.

The cruises which will be made in the summer of this year will give us an tremendous lot of valuable information. We will be able to arrive at a comparison of the effectiveness of the work on the various areas, the efficiency of fall spotting and the effectiveness of spring and summer control work.

Comparison of beetle and fire losses for one year, 1922.

	Fire Losses In Oregon. 1.	Beetle Losses on S. Oregon Project 2.
Total acreage protected, 1922	9,000,000	1,250,000
Losses in volume of B. F.	69,659,000	91,961,000
Monetary value of timber killed not saleable	$167,577.00	$275,883.00
Money spent for protection	$446,921.47	$ 55,246.19

Notes: 1. Data on fire losses taken from State Foresters Annual Report of 1922 which covers all State and privately protected timberlands outside of National Forest Boundaries.

2. Data on beetle losses from cruises and estimates on Southern Oregon Project, representing 5% actual count.

MR BURKE: Cards are tacked to the trees to identify them?

MR KEEN: Yes, The method of using the card for spotting is successful with us. We use a card and place it in an envelope for protection.

MR MILLER: Mr. Keen do you have the comparative cost of your crews, the per cent that constitutes for the cruising methods for the entire project?

MR KEEN: It is estimated that these losses figure about 5% actual cruise. Last year's survey was based on 1% cruise of the area at a cost of about $3,000 last year and $4,000 this year, but I think it was worth it.

KLAMATH INSECT CONTROL PROJECT.
By
H. E. Burke.

This project was an attempt to control the western pine beetle in yellow pine in the Big Humbug, Little Humbug, Barkhouse and Moffat Creek basins of the Klamath National Forest near Yreka, Calif. The Moffat Creek and Big Humbug basins are fairly well isolated and the Little Humbug and Barkhouse Basins taken together are the same. The total acreage is 79,000 acres, the principal owners being the Forest Service and the Central Pacific Railroad Co., Of the 1300 infested trees treated, 1007 belonged to these two owners, 490 to the Service and 517 to the Railroad. The stand of timber involved is fair and moderately accessible. It contains about 480,000,000 bd. ft. and was valued at the time of the control work at about $1,000,000.

The timber was dying at a fairly constant annual rate about 10% of the stand having been killed in the ten years from 1900-1911. On some sections 75% of the timber had been killed by the Western Pine Beetle.

In 1912 the larger owners carried on cooperative control work. On the Big Humbug, Little Humbug and Barkhouse units the Forest Service did the work and charged the cost of the treatment on the Railroad land to the Railroad Co. On the Moffat Creek unit the Railroad and several small owners did the work independently, advice and supervision was furnished by the Bureau of Entomology. Some of the work was done by ranger labor and some by day labor. Some of the crews subsisted at farmhouses and some made camps, hired cooks and carried in their food, etc., by horse and wagon or by pack train.

The 1912 control work started on the Big Humbug unit on January 5th and ended on the Moffat Creek unit on May 10th. Thirteen hundred trees were treated, 1274 of these were yellow pine and 26 were sugar pine. The volume treated was 762,300 bd. ft. and the acreage covered 79,000 acres. The 91 sections treated averaged 14.3 trees to the section and each tree averaged 586 bd. ft. to the tree.

The total cost was $3754.13, cost per tree $2.88, cost per thousand bd ft. $4.92, cost per acre treated $.047.

The results of the control work should be considered in units as that is the way they were cruised and treated at the time, really treated as separate projects.

On the Big Humbug (Craggy Mountain) unit 544 trees were treated in 1912, In 1913, 193 trees were found infested (65% reduction), 178 of these were treated. In 1914, 63 trees were infested. In 1915 a trip through the area indicated that very few trees were infested and that the broods in these were being destroyed by natural enemies such as birds, etc.

On the Barkhouse unit 383 trees were treated in 1912. These included the trees in the little Humbug basin. In 1913, 174 trees were infested (55% reduction) and in 1914, 69 trees. In 1915 a trip through the area indicated that conditions were as on the Big Humbug Unit.

On the Moffat Creek unit 373 trees were treated in 1912. In 1913, 30 trees were treated on one section of the unit. In 1915, 41 trees were found infested on the area.

The control appeared to be very successful for three years. In 1916 however, there was a heavy general infestation throughout northern California.

and Southern Oregon. This is reported to have overcome the results of the control work carried on in these areas.

See reports by Burke, June 10 and 14, 1912; by Glendinning, July 1914 and January 14, 1915.

HISTORY AND REVIEW OF THE
YOSEMITE CONTROL PROJECT.
By
J. E. Patterson.

1. Yosemite Park Control Project:

2. Primary Insects:

The primary insects responsible for the losses in pine timber on this project were *Dendroctonus brevicomis* in yellow pine, *Dendroctonus monticolae* in sugar pine, and *Dendroctonus jeffreyi* in Jeffrey pine.

3. Location of Project:

The project areas are located in the Yosemite National Park, California. The yellow and sugar pine areas are located on the Yosemite Valley floor, Unit 1, in the higher elevations adjoining the valley on the west, Unit 2, and on the southwest, Unit 3, the Jeffrey pine areas are situated in; the Little Yosemite Unit 4, and in the Snow Creek basin, Unit 5. The attacked map shows the location of these areas or units.

4. Acreage Involved:

The approximate acreage of these areas is:

Yellow and sugar pine areas, Units 1, 2, 3,	22,000 Acres
Jeffrey pine areas, Units 4 and 5.	6,000 "
Total	28,000 "

The ownership of all these lands is held by the Yosemite National Park.

5. Timber Resources Involved:

The character of the yellow pine and sugar pine timber is of high quality. The Jeffrey pine is of low merchantable quality. The timber is all more or less inaccessible from a logging or utilization standpoint. Its value lies altogether in the aesthetic value for park purposes. However, the merchantable value would approximate $4.00 per M.

6. Extent of Losses Previous to Control Work:

The extent of insect losses during the three years previous to control work in 1918, on the areas involved, are shown in the following tables. It is explained that the infestations of *D. brevicomis* and *D. monticolae* in yellow and sugar pine and their losses are given together and are not segretated according to host tree or insect species attacking as practically all the yellow pine are attacked by *brevicomis* and the sugar pine, which were attacked by *Monticolae*, represented such a negligible quantity that separation was not worth while in this memo.

TABLE I. - Loss by D. brevicomis in yellow pine and by D. monticolae in sugar pine previous to control work:

Year	No. Trees	Volume	Increase or decrease of infestation in volume over preceding year: Increase %	Decrease %
1915	62	125,070		
1916	43	91,220		27%
1917	49	156,500	71%	
Total	154	372,790		

TABLE II. - Loss by D. jeffreyi in Jeffrey pine previous to control work:

1916	42	67,200		
1917	34	63,200		6%
Total	76	130,040		

It is impossible to give the loss in percentage of stand as no stand figures are available for these areas.

7. Organization of Project:

Note: Control work was carried out in these areas during the years 1913, 1914, and 1915, by the Yosemite National Park under the supervision of J. J. Sullivan, a representative of the Bureau of Entomology. Records of this work in the files of the Ashland Station are so incomplete and unsatisfactory that it is practically impossible to get any data of value out of them.

The organization of the work given here was effected on the following basis:

Basis of Cooperation: Organization, administration and supervision of the control work were handled entirely by a representative of the Bureau of Entomology. J. E. Patterson was detailed in this capacity during the period of the project. The Yosemite National Park paid the total cost of the work and all salaries except that of the Bureau's representative. The Park also supplied the laborers, tools and equipment.

Working Plans: The working plans called for the treatment of 100% of the infestation in the Yosemite Valley, Unit 1; and of the treatment of 75% of the infestation in the worked areas surrounding the valley. The work was to be started in the spring of 1918. The aim of the spring periods of work was to treat the required percentage of the overwintering broods. The spring work was to be followed by summer intensive work in the Yosemite Valley only with the expectation that the insects would be entirely eradicated in this part of the project. Summer work was not planned for the areas surrounding the valley.

The control work in 1919 was to be organized and conducted on the same plans provided for the work in 1918.

The Bureau's representative made the preliminary surveys, marked all the trees treated, and supervised the work of treating the infested trees. The trees were felled, peeled and the infested bark burned.

Labor: Laborers necessary for the work were recruited from the personnel of the Park Service and were paid a daily wage including subsistence.

Transportation and Camp Organization: Transportation was effected by auto trucks in the Valley, and in the yellow pine areas west and south of the valley; units 2 and 3. Transportation to the Jeffrey pine areas, units 4 and 5 was by pack horse. Headquarters for outfitting, etc. were in Yosemite Village.

A camp was established in each area or unit during the period of work on that unit. Tents were used for shelter. Each man cooked his own food and furnished his bed.

8. - Amount of Timber Treated:

First Year, (1918) - April 12, to Aug. 20.

Designation	Yellow and Sugar Pine	Jeffrey Pine
Number trees treated	46	31
Volume treated	159,680	60,900
Average number trees per section	2	6
Average volume per tree	3,471	1,965
Acreage covered	14,000	3,200
Acreage protected	22,000	5,120
Man-days	50	28
Cost per tree	$4.30	$6.00
Cost per M.B.M.	$1.24	$3.05

Second Year, (1919) - May 15 to Aug. 15.

Number trees treated	23	0
Volume treated	61,250	
Average number trees per section	1	
Average volume per tree	2,663	
Acreage covered	10,000	
Acreage protected	22,000	
Man-days	28	
Cost per tree	$5.10	
Cost per M.B.M.	$2.00	

Total Period - April 12, 1918 to Aug. 15, 1919.

Total number trees treated	100
Total volume	281,830
Average volume per tree	2,818
Averag e number trees per section	4
Acreage covered	17,200
Acreage protected	27,120
Total man-days	106

9. Total Cost:

Note: Cost figures for the work in 1919 are only approximate as these were not kept separate in the Park accounts.

Total Cost of work	$501.10
Cost per tree	$ 5.01
Cost per M.B.M.	$ 1.78
Cost per acre treated	.03¢
Cost per acre protected	.02¢
Cost per man-day	$ 4.73

10 - Results.

The results of the control work of the first year were satisfactory in all areas except the Yosemite Valley, Unit 1. In this unit the recurring infestation amounted to 90% of the infestation treated in 1918. In all other yellow pine areas the subsequent infestation of 1919 amounted to only 18% of the 1918 infestation.

The volume of yellow pine and sugar pine timber saved the first year amounted to approximately 260,000 b.f. The percent of reduction in these areas the first year amounted to 86%.

The results obtained from the first year's work in the Jeffrey pine areas was so satisfactory that no more work was done the following year. The per cent of reduction in these areas following the first year's work was 80%. The volume of timber saved amounted to 34,000 b.f.

The volume of timber saved the second year in the yellow pine areas amounted to 85,000 b. f. The per cent of reduction in these areas for the year was 64%.

No work was done the second year in the Jeffrey pine areas.

The total saving over cost of work, assuming the stumpage value at $4.00 per M. amounted to:

Total volume saved by the two years work	379 M.B.M.
Value @ $4.00 per M.	$1,516.00
Total cost of work	$501.10
Total saving over cost of work	$1,014.90

However, the greatest saving was not in the commercial value of the timber but was in the protection of the stands for park purposes. The control work should be considered in the light of insurance against annual losses which would, in time, greatly deplete the stands and render the timbered areas unsightly from an aesthetic point. It is evident that control work in National Parks must not be judged by the standard of cost values of the timber saved, as in control work done in commercial stands, but must be comparable, in a degree, to other accepted work, such as tree surgery, and landscape gardening, which is practiced in beautifying parks. The intrinsic value of such work is difficult to judge.

11. Subsequent History of Controlled Areas.

The subsequent history of the controlled areas is not known to the writer. To the extent of his knowledge there has been no surveys made of the areas since 1919. Therefore no data is available.

BIBLIOGRAPHY

The following reports and memorandums on the project are on file in the Ashland Station.

1. Memorandum of Extracts from Sullivan's Report on Control Work in 1915. By J. M. Miller, Sept. 1916.

2. Memorandum of Recommendations, Yosemite Control Project. By - J. M. Miller, Dec. 19, 1917.

3. Forest Insect Control, Yosemite Project, First Report. By - J. M. Miller and J. E. Patterson, Jan11, 1919

4. Forest Insect Control, Yosemite Project, Second Report. By - J. E. Patterson, Dec. 15,1919

ARROWHEAD LAKE PROJECT
(Formerly Little Bear Lake)
By
R. D. Hartman.

San Bernardino Mts. - Angeles National Forest.

PRELIMINARY SURVEY AND RECOMMENDATIONS:

Recommendations leading to the initiation of control work on this area ware bases upon a survey made by J. M. Miller and R. D. Hartman, of the Bureau of Entomology, duringthe period March 6 to 10, 1922. The results of this survey were covered in a memorandum to Forest Supervisor Charlton dated March 12, 1922.

In this examination it was found that the infestation of the western pine beetle was present in yellow pine and Coulter pine, and that it was distributed throughout a tract of about 8000 acres including 5000 acres belonging to the Arrowhead Lake Company, and 3000 acres of adjoining National Forest lands. The cost of treating this infestation was estimated at $300.00 It was proposed that the Arrowhead Lake Company, the Angeles National Forest, and the Bureau of Entomology cooperate on the control, the two owners contributing jointly to the cost of the labor, and that the bureau detail a man to demonstrate the control methods and supervise the project. When it was found that the control fund of the Forest Service could not be allotted to this area, the Arrowhead Lake Company offered to treat the infested trees on the Federal lands as well as its own in order to insure the removal of the infestation throughout the entire area.

PERIOD OF CONTROL WORK:

Control work was started March 10 but discontinued because of heavy snow. It was started again on April 12 and completed April 26. This work was under the direction of R. D. Hartman of the Bureau of Entomology.

COOPERATION:

The Arrowhead Lake Company cooperated in every way possible to make the control project a success. In addition to the subsistence provided for the Bureau of Entomology representative, a saddle horse was also placed at his disposal which enabled a closer supervision of the work and a rechecking of the area for infested trees which did not fade until the latter part of the control period.

Ranger Tuttle was detailed for several days by Supervisor Charlton, during the first part of the control work to receive instructions as to the method of control, but unfortunately was taken off for other work.

AREA COVERED BY CONTROL WORK:

The infestation on the following sections was treated:

Section 18 T. 2N., R. 2W., S.B.M.
Sections 2,3,4,5,6,8,9,10,11,13,14,15,16, and 17 T. 2N., R. 3W., S.B.M.

ORGANIZATION OF WORK:

As the Arrowhead Lake Company had a construction camp in operation on the area, laborers were assigned from this camp to the insect control work. It was possible to reach all of the infested trees from this central camp, thereby eliminating the necessity for charge against the project of camp equipment or transportation. Men were assigned as needed but as a rule four crews of two men each were used. A wage scale of $3.20 per day of 9 hours with a charge of $1.20 for subsistence was maintained.

CONDITIONS:

The timber belt of this area forms a belt approximately five miles in width extending along the crest of the San Bernardino Mountains. The timber type is composed of yellow pine, Coulter pine, sugar pine, Jeffrey pine, and white fir. Most of this timber lies between the elevations of 5000 and 6000 feet and within the drainage of Little Bear Creek.

The infestation can be considered as endemic, but most of it appears in small groups of from two to four trees. It is definitely boundedoon the north and south sides by absence of pine type due to desert conditions. The pine belt extends for a considerable distance to the east and west of the area, but a distinct break in the infestation is noticeable on the eastern and western borders of the area included in the project.

PRIMARY INSECTS INVOLVED:

NAME		STAGE OF	HOST
Scientific	Common	INSECT	TREE
D. brevicomis (Lec)	Western Pine Beetle	Young to full grown larvae, pupae new and parent adults (alive)	Yellow and Coulter Pine
D. valens (Lec)	Red Turpentine beetle	Large larvae and adults	Yellow and Coulter Pine
D. monticolae (Hopk)	Mountain Pine Beetle	Old parent adults	Sugar pine
Ips confusus (Lec)	Five-spined Bark beetle	New adults	Yellow and Coulter Pine

D. brevicomis was most common in the full grown larval stage, although a few pupae and recently changed adults were notes. Also living parent adults and young larvae were found on two different occasions. One being in a lower limb of a former attacked tree, while the others were found common on the trunk of a brood tree.

D. valens larvae were taken from the bases of a number of trees, and in one case, full grown larvae and new adults from the base to 12 feet from the ground.

Ips confusus was taken only in the new adult stage from the majority of tops and limbs of trees infested with D. brevicomis. One group of 12 yellow pines (8-12") were heavily infested with this species.

In the case of D. monticolae in the sugar pine only one host ttee was observed, which had been attacked at least two years previous. While a number of Jeffrey pines were noted on the project, only one showed insect attack of a Melanophila sp. No specimens were found.

One of the outstanding characteristics of the infestation was in the attacks of trees in groups of two's and four's. Thirtytwo (or 50% of the infested trees treated) were in groups of two's. Two of these being yellow pine, while the two groups of four's consisted of one yellow pine and one Coulter pine group.

METHOD OF WORK:

Forest management, to the extent of careful falling and burning, was observed regardless of time spent on a tree. The primary purpose of protection on this area is to preserve the recreational value of the forests surrounding Arrowhead Lake. Large mature trees have a very high intrinsic value where they stand in scenic situations. The preservation of individual trees for this purpose rather than for commercial considerations was the aim of the control work. The infestation, therefore, was worked much more intensively than would have been the case in commercial forests.

Trees as a rule were felled up or down the slope to insure the tree from rolling during the burning. The fires were held in check by throwing soil on the flames, as an intermittent wind prevailed during the greater part of the work. After burning, the trees were revisited several times to see that all evidence of fire had gone.

CONTROL DATA:

	Yellow Pine	Coulter Pine	Total
Number of trees	20	44	64
Total Volume	43,700	33,330	77,030
Average Volume	2,185	757.5	1,203.6
Smallest Diameter	16"	14"	
Largest Diameter	62"	42"	
Average Diameter	36.3	26.3	29.3

COST OF PROJECT

A. Treating of infested trees
Arrowhead Lake Company
Labor and subsistence ------------------$304.00
* Equipment (borrowed from Arrowhead Lake Company's Construction work)

B. Demonstration of methods
Bureau of Entomology

Salary R. D. Hartman (including survey)	170.00
Travel " " " (" ")	60.00
	$230.00

C. Average Costs:

Cost per tree	4.75
Cost per M.B.M.	3.80
Board feet per man per day	810.8'
Trees per man per day	.7

Summary of time and cost (including percent) of individual control activities:

	Total Man Hrs.	Hrs. per Tree	Cost per Tree	Per-cent
Time walking to trees	138	2-10/64	.76-6/9	.16
Felling	136	2-8/64	.75-5/9	.16
Peeling, Limbing, and making firelines	435	6-51/64	2.41-6/9	.51
Burning	146	2-18/64	.81-1/9	.17
TOTALS	855	13-23/64	4.75	100%

VOLUME TREATED ACCORDING TO OWNERSHIP:

Arrowhead Lake Company:

Tree Species	Number	Volume
Yellow Pine	16	38,770
Coulter Pine	9	5,840
	25	44,610

Angeles National Forest:

Tree Species	Number	Volume
Yellow Pine	4	4,930
Coulter Pine	35	27,490
	39	32,420

MR METCALF: I am wondering if any of the gentlemen have made notes as to whether the beetles get out of the bark when it is burried in the ground and whether you heat the bark up enough by burning the bark around the tree in order to kill the one-third area. Does that actually kill the beetle or do some beetles emerge afterwards?

MR HARTMAN: If you pile the bark up close to the tree and burn it, my experience has been that the beetles will not escape. The unpeeled bark gets very hot and in many cases the fire keeps under the log; heavy butts that are sunk in the ground quite a ways, I don't believe the beetles could escape thru. Those around the edge, I am satisfied get enough heat to kill them. The degree of heat is well above 120.

MR METCALF: The comarison wouldn't be fair because in the other project some of those beetles wouldn't get out anyway.

ANTELOPE CONTROL PROJECT

SISKIYOU COUNTY, CAL.

By
J. E. Patterson

HISTORY AND REVIEW OF THE PROJECT TO DATE.

1. Location:

The Antelope Control Project is located in Siskiyou County, Cal. The main body of the area lies east of Antelope Creek in the high plateau region in the northeast part of the Shasta National Forest. The attached map of this section of the Shasta Forest shows the location of the project area.

2. Acreage Involved: Ownership:

The total acreage of the project area as outlined at the inception of the project was 104 sections or 66,000 acres. However, a part of the area 14,000 acres, was excluded from the project the first season of control work as logging operations on this part precluded the necessity of protecting the timber from further insect losses. Exclusive of this logging area the total acreage of the Antelope project is 84 sections or 52,000 acres.

With the exception of some small "shotgun" areas owned by the Shasta National Forest the project area is under the ownership of the Weed Lumber Company.

3. Timber Resources Involved:

The timber on the area is composed almost exclusively of western yellow pine of good merchantible quality. It is readily accessible by good wagon roads. Logging railroads from Tennant, California are under construction on the area. The merchantable value of the timber is approximately $3.50 per M. The average stand per acre will approximate 10,000 board feet.

4. Extent of Losses Previous to Control Work:

It is known that the insect losses on the area have been heavy for the past ten years. Control work conducted by the McCloud River Lumber Company under the direction of the Bureau of Entomology during the years 1914 and 1915 resulted in checking the high annual infestations and reduced the losses to a low point, However, no efforts were made to maintain this low status with the result that during the succeeding four years the infestation re-developed to and even exceeded the status at the time control work was started.

Surveys made by the Bureau of Entomology in 1920 and 1921 resulted in securing reliable data on the annual losses for the years 1918, 1919, and 1920; the three years immediately preceding the present project. These losses are shown in the following table.

Table I. - Losses on Area Previous to Control Wirk:

Year	Insect and tree sp.	No. trees	Volume	% of Stand
1918	D. brevicomis Y.P.	8,777	7,504,000	1.4%
1919	" " "	8,896	7,606,000	1.4%
1920	" " "	7,592	6,453,000	1.2%

5. Primary Insect Responsible:

The primary insect responsible for the losses on this project is Dendroctonus brevicomis. This species was associated in attacks with Dendroctonus monticolae, Ips emarginatus, Ips confusus, and Ips oregonis. However, the number of trees killed by any of these secondary insects either alone or in combination was negligible.

6. Organization of Project:

(a) Basis of Cooperation: Working Plans:

At the request of the Weed Lumber Company the Bureau made preliminary surveys of the area in June and August, 1920. The object of these surveys was to ascertain the amount and character of the insect infestations and losses on the area and to serve as a basis for a memorandum to the Company setting forth these losses with recommendations for remedial measures in case it was decided to inaugurate control work. As a result of these surveys it was found that an epidemic infestation of D. brevicomis existed in the pine timber on the area. The Weed Company decided to protect the timber from further losses and applied to the Bureau for technical advice and methods used relative to control work against this beetle.

The following agreement and working plans for the conduct of the control work were entered into by the Bureau of Entomology and the Weed Lumber Company in the fall of 1920. This agreement and working plan provided for the conduct of the control work by employing only methods recommended by the Bureau. The organization of the control forces and the administration of the work were to be handled entirely by the Weed Company. The province of the Bureau, under the agreement, was to consist of the giving of technical advice of an entomological nature and the demonstration in the field of the methods of control adopted and recommended for this area. The field representatives of the parties to the agreement were Mr. Chas. W. King, representing the Weed Co., and J. E. Patterson, representing the Bureau. Later, during the winter of 1922, at the suggestion of the Weed Co., and with the approval of the Bureau, the cooperation was extended to and accepted by the Shasta Forest, thereby reaching with cooperation and plan, all parties primarily interested in the project. Participation by the Shasta Forest consisted of paying the Weed Company, on a per treated tree basis, for control work done on the National Forest lands within the project.

This agreemant was maintained and was effective througout the first years work and was conductive to a complete correlation of forces and most gratifying results. However, the Weed Company in the spring of 1922 decided, for economic reasons, to contract the control work for the ensueing season on a per treated tree basis, and made arrangements to this end by giving Mr. R. P. Box, Kings former assistant, a contract to carry out the control work for the year recommended as necessary by the Bureau. The work was contracted to Box on a basic price of $3.00 per tree treated and was to be carried out under the supervision of King, with technical advice from the Bureau.

As contract control work in general and more especially as applied to maintenance of control is foreign to the policy of the Bureau owing to a number of operating factors, the agreement was abrogated and the Bureau withdrew its active participation in the project in order to protect itself from adverse criticism which might arise through faulty application of its principles and methods of control as conducted by a contractor. However, through the Bureau's interest in the successful prosecution of the control work and the possibilities of the project giving useful and valuable data through a continuation of the plan of control originally adopted, and the fact that the Weed Company still wished to continue the cooperation the agreement was continued under the following modified form:

The Bureau's participation is limited to periodical examinations of the area and inspection of control work done; to the giving of technical advice on all matters pertaining to methods used and the amount and location of the infestation to be treated. It does not assume responsibility for the results of the contract control work or guarantee the success of the project under the contract arrangement.

This modified agreement was acceptable to both the Bureau and the Weed Company; the latter being represented by Chas. W. King. The latter agreement was adherred to throughout the second year's work. The Shasta Forest cooperated on the plan in the original agreement.

(b) Working Plans:

The working plans embodied in the first agreement were not materially changed during the progress of the work to date. These plans entailed a general initial attack by intensive control work during the late fall and spring which was directed toward the removal and treatment of from 50% to 70% of the over-wintering infestation on as much of the project area as could be covered during these periods. This work was to be followed during the summer by maintenance work involving: Treatment of accessible standing trees infested with summer broods and by making use of trap trees to localize the summer infestation so that a high percentage of it could be treated with the minimum of time and cost.

(c) Transportation, Camp Organization: Labor:

These details were worked out and handled entirely by the Weed Company as provided under the agreement.

A central camp was organized and located in the central part of the area so that all parts could be readily reached by Auto trucks. The personnel of the camp consisted of the general foreman, his assistants (who also spotted the infested trees for treatment) cook and helper, and the men who composed the treating crews. Tents were used for mess and sleeping quarters. Transportation of supplies to camp and of the crews to and from work was effected by auto trucks.

(d) Supervision:

The administration of the work was under the supervision of Chas. King. The representative of the Bureau was on the area a good portion of the time and attended to the technical details of instructing the men in methods of spotting and treating infested trees and outlining the amount and character of work to be done.

7. Amount of Timber Treated First Year:

First Year:

Total Period of work	Sept. 11, 1920 to Oct. 31, 1921.
Total acreage covered	26,880 Acres
Acreage protected	35,000 "
Number of trees treated	4,179
Volume treated	3,590,360 b.f.
Average No. trees per section	100
Average volume per tree	855 b.f.
Average number of men employed	14
Number man days	2,565

Separate periods:

Fall Work

Period of work	Sept. 11, to Nov. 30, 1920
Acreage covered	7,040 Acres
Acreage protected	10,000 "
Number of trees treated	345
Volume treated	261,170 b.f.
Average number trees per section	31
Average volume per tree	757 b.f.
Number man days	344
Total Cost	$2,869.40
Cost per tree	$8.31
Cost per M.B.M.	$11.00
Cost per acre	.38

Winter Spotting:

Period of work	Dec. 1, to Mar.20, 1921
Acreage covered	10,000 Acres
Number trees marked	2,000 "
Number man days	261
Number trees per man per day	7.7
Cost of work	$1,841.62
Cost per tree	.93
Cost per acre	.14½

Spring Control Work:

Period of work	Mar. 21, to June 16,1921.
Acreage covered	19,840 Acres
Acreage protected	25,000 "
Number trees treated	2,840
Volume treated	2,332,380 b.f.
Average No. trees per section	92
Average volume per tree	820 b.f.
Number man days	1,241
Cost	$8,135.75
Cost per tree	$2.83
Cost per M.B.M.	$3.49
Cost per Acre	.41

Summer Maintenance:

Period of work	June 17, to Oct. 31, 1921.
Acreage covered	26,880 Acres
Acreage protected	35,000 "
Number trees treated	1,012
Volume treated	996,810 b.f.
Average No. trees per section	24
Average volume per tree	985 b.f.
Man days	719
Cost	$4,348.78
Cost per tree	$4.30
Cost per M.B.M.	$4.36
Cost per acre	.16

Distribution:

Falling and preparing trap trees	$1,005.60
Cost per tree	$1.50
Cost per M.B.M.	$1.82
Treating windfalls, trap trees and standing summber brood trees @	$3,343.18
Cost per tree	$3.30
Cost per M.B.M.	$3.35

Total Cost of Year's Work:

Total Cost	$17,195.55
Cost per tree	$4.10
Cost per M.B.M.	$4.79
Cost per acre treated	.64
Cost per acre protected	.49

Second Year:

Total Period:

Period of work	April 20, to Aug. 15, 1922
Total acreage covered	40,000 Acres
Acreage protected	52,000 "
Number trees treated	1,999
Volume treated	1,803,890 b.f.
Average No. trees per section	32
Average volume per tree	955 b.f.
Number man days	500

Total Cost:

Cost	$6,600.00
Cost per tree	$3.31
Cost per M.B.M.	$3.65
Cost per acre treated	.16½
Cost per acre protected	.12½

9. Total Cost of Project to Date:

Period of operations	Sept. 11, 1920 to Aug. 15, 1922.
Total number trees treated	6,196
Total volume	5,394,250 b.f.
Total acreage covered	40,000 Acres
Total acreage protected	52,000 "
Total man days	3,065
Total cost	$23,795.55
Cost per tree	$3.84
Cost per M.B.M.	$4.41
Cost per acre treated	.59½
Cost per acre protected	.45½
Cost per man day	$7.76

10. Results:

First Year:

The general results of the first year's work consisted of the covering by intensive control work, 52% of the acreage of the entire project area and of protecting by this work and summer maintenance work 67.3% of the whole area.

The infestation on the project area was materially reduced and the epidemic which had existed for at least three years preceding the control work was broken.

Approximately 56% of the total overwintering infestation of 1920 was treated during the fall and spring intensive work.

The reduction in the annual losses which resulted from the years work amounted to 63%

The volume of timber saved by the years work amounted to a total of 5,706,000 b.f. This saving was made at a total cost of $17,195.00 or assuming the stumpage value at $3.50 per M. there was a net saving over cost of control work of $2,776.00.

Second year:

With the completion of the second years work 77% of the project area has been covered by intensive control work and the entire area has been protected. The reduction in annual losses has been from 7,606 M.B.M. in 1919 to 1,900 M.B.M. in 1922, or a reduction of 75%.

The annual loss has been reduced, due to the control work accomplished during the two years, from 1.4% to .4% of the stand or an actual saving of 1% of the stand annually.

The volume of timber saved the second year amounted to 3,000 M.B.M.

The total saving over the cost of work to date is: assuming the stumpage value at $3.50 per M:

Volume saved in 1921	-------5,706 MBM @ $3.50	-----$19,971.00
Volume saved in 1922	-------3,000 " @ $3.50	-----$10,500.00
Total volume saved	-------8,706 " @ $3.50	-----$20,521.00
Total cost of work	------------------------------	$23,795.55
Net saving over cost of work	------------------------	$ 6,725.45

11. Subsequent History of Controlled Area:

As the project has not yet been completed there is, of course no data available on this head.

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THE SAN JOAQUIN PROJECT
Maintenance Control Method.
By
J. M. Miller.

After the problem of control of epidemic infestations has been solved, the next step is that of maintenance control. The timber owner that makes an investment of $50,000.00 in the cleaning up of an infestation within his holdings desires some assurance that the results secured by this work bill be protected. If within the course of a few years the epidemic condition builds up again in the same tract of timber, his initial investment may be entirely lost.

The most effective methods of maintenance control are still to be determined by experimental work. There are two apparent approaches to the problem; to carry on a certain amount of control work on endemic infestations to prevent the epidemic; and to rely upon methods of forest management so as to maintain conditions unfavorable to the development of epidemics. In the protection of reserves of mature timber which must be held for a number of years before they can be logged, the carrying on of a certain amount of control work under endemic situations appears to be the most immediate method of maintaining the desired control. The San Joaquin project was a cooperative experimental undertaking by the Bureau of Entomology and the Forest Service for the purpose of testing out methods of maintenence control.

Conditions of the San Joaquin Area:

The area selected for this test consisted of 130,000 acres with a volume of approximately two billion feet of yellow pine and sugar pine. The primary infestation is D. brevicomis in yellow pine and D. monticolae in sugar pine. Logging is just being initiated in the area. It is probable that much of the timber will have to be held for 25 or 30 years before it can be marketed. Control work has been carried on since 1911 by both Federal and private owners. Up until 1920 funds to the amount of $24,000.00 has been invested in the control of what were considered epidemic infestations.

History of Maintenance Control:

The initial plan for this work was to carry on direct control work under endemic conditions, by treating of trees wherever conditions appeared to warrant the work. The intention was to maintain a small permament organization for this work, and to treat first of all any portions of the area where concentrations of beetles or incipient increases appeared to be developing. Both spring, summer and fall work were included in the plan. In case no definite centers developed, the work was to be kept up by spreading the control over the

entire area, treating accessible infestation under a fixed annual expenditure. Experimental tests of methods such as the use of trap trees and the solar heat killing of broods were also features of the project.

1920

In the spring of this year maintenance control was initiated. The infestation was considered endemic for the entire area, the loss of the preceeding year amounting to 2,923,000 board feet or about .15 of 1% of the pine volume.

The amount spent upon spring and summer control work was $7,135.00. The losses for 1920 amounted to 1,551,480 board feet, less than one tenth of 1% of the stand and a reduction over the preceding year of 1,471,700 board feet or 50% in volume.

1921

This season only summer maintenance control was attempted, the aim being to spread the protection over the entire project area at a cost not to exceed 3 cents per acre. Work was carried on where the infestation was the heaviest or most accessible, trap trees were used to a considerable extent but no attempt was made to work the entire area or to work any part of it intensively. A total of $3,709.07 was expended.

The season proved to be one of generally increasing infestation both within and without the project area. The annual loss increased to 2,798,380 feet, or nearly as great as 1919. The conclusion from this season's work was that under an increasing infestation, a light application of maintenance control treating less than 50% of the seasonal infestation is not sufficient to check the increase.

1922.

Under the revised plan adopted for this season, the actual control work was limited to approximately 24,000 acres in the Chiquito District and the entire balance of the project area was closely cruised and studied as a check.

The control area was divided into small units averaging about 4,000 acres each. The method of control was varied for each of these units.

As yet only the cost figures are available for work carried out during 1922. A summary of these is given in Table III. The average cost of $7.25 per M. is not unduly high when the conditions of the project area are taken into consideration. Trail improvements, such as building a bridge, over Chiquito Creek, were essential to the continuation of the project and could only be financed from the control fund. This activity, together with fire-fighting,

packing, and getting men to and from the control area amounted to nearly 22% of the costs of the project.

Detail of the costs on the individual units of the Chiquito Districts are given in table IV. It was possible to consistently work only four of the units outlined.

26a - Logan, Spring and Summer work with traptrees.

A good clean up was secured on the overwintering infestation on this unit. The follow up work during the summer was limited mainly to trap trees. The high cost of $14.62 was due to concentration of work upon trap trees of small diameters.

26b - Forked Meadow Extermination.

The purpose of this unit in the plan is to determine whether highly intensive control work is possible and feasible, upon a small non-isolated area. The work on this unit was given precedence and any modifications of the plan that were necessary were made on other units. This unit was cruised 12 times during the season and only a very small percent of the infestation escaped treatment. In the final cruise made of the unit the latter part of November only two infested trees could be found. This sort of work cost 45¢ per acre and if the results secured are permanent intensive work may in the long run prove to be practicable.

26c - West Chiquito Spring and Summer work without traptrees.

Owing to the shortening of the spring work by warm weather in May a lower percent of the overwintering infestation was treated than planned. More of the summer infestation would also have been treated had it not been for the unexpected amount of work which developed on Unit 26b and the trap tree work on Unit 26a.

26d - Arnold Check

In the revised working plan of April 1922, it was proposed to cover this unit with spring work. This plan was abandoned in May when it was found that the work could not be completed before the emergence of the spring broods. Only two trees were treated but the unit was closely cruised as a check.

27a - Fullers Check.

This small unit was originally included in 27, which was to be marked as a check. Owing to a misunderstanding by the crew foreman the unit was covered with spring work. It will not be worked in the spring of 1923 but will be studied as a check.

28 - Dalton, Spring work.

This unit was covered with spring work in 1922 according to the original plan.

Plans for Season of 1923.

It is essential that the general plan now in effect be continued during the seasons of 1923 and 1924. When the results for these seasons become available some conclusions can be drawn and recommendations made as to the methods best adapted to maintenance control and feasibility and costs of their application.

During the season of 1923 the working plan initiated during the season of 1922 will be followed as closely as it is possible to do so. Any modifications of this plan will depend upon emergencies that may develop during the course of the season's work. The carrying out of spring work on unit 26 d will depend as in 1922 upon conditions developing at the close of the spring work.

Owing to the high cost and negative results secured through the use of trap trees on this area they will be discontinued if it is found that funds for the project will not be sufficient to carry through all the other work outlined.

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SHADE TREE INSECTS

By
H. E. Burke.

To the Forest Entomologist, shade tree insects probably do not appear to be of much importance. Let us stop a moment and carefully consider the matter. Last year at Pebble Beach on Monterey Bay in the famous Del Monte grove of Monterey Pine which is valuable because of its recreational or ornamental use, $60,000.00 were spent for insect control on an area of 1,000 acres. Think how hard it would be to get a lumberman to spend such an amount to protect his timber from insect depredations. Owners of individual trees have spent from $100.00 to $500.00 a number of times to protect them from injurious insects. Think of the many more people who own shade trees and are directly interested in them as compared with the owners of timber trees. Compare the appropriation of $600,000.00 for Preventing Spread of Moths which is primarily a shade tree appropriation with the $40,000.00 for Forest Insects and you can readily see that to the general public shade tree entomology is important.

On the Pacific Coast we have a great variety of shade trees and ornamentals, both native and introduced. Along with them we have a great variety of insect pests, also both native and introduced. All parts of the tree from the flower buds to the roots are attacked and injured or destroyed. As with forest insects we have the endemic infestations every year and epidemic infestations periodically.

One of the most important of the flower pests is the rose weevil, Rhynchites bicolor, which punctures the buds and often completely ruins the first crop of some varieties of roses. Another important flower pest is the Diabrotica or cucumber beetle, Diabrotica soror, which feeds on the flowers of the rose, chrysanthemum, aster, zinnia, and other ornamentals. The foliage pests probably are most noticed by the general public. Caterpillars such as the tent caterpillar, tussock moth, California oak worm, and penstemon caterpillar completely defoliate many plants. Scales, aphids, psyllids and plant bugs suck the juices from the leaves and twigs and either cause them to wilt or cover them with sticky, smutty, dirty honey dew which destroys their ornamental value. The twigs and smaller branches are mined and killed by various borers such as the Pacific Oak Twig Girdler, Agrilus angelicus, and by gall wasps, Cynipidae. Sometimes some of the bark beetles such as Phloeosinus mine many small branches which cause them to break over. The larger branches and the main trunk have their bark riddled by bark beetles such as the cypress bark beetles, Phloeosinus cristatus and P. cupressi, the alder bark beetle, Alniphagus aspericollis, the ash bark beetle, Leperisinus californicus, the pine bark beetle, Ips confusus, I. radiatae, I. plastographus and Dendroctonus valens, the pine bark weevil, Pissodes radiatae, the flathead borers, Chrysobothris mali and C. femorata, and various Lepidopterous borers such as the peach borer, Aegeria exitosa.

The wood of the trunk and the branches is riddled by the mines of the carpenter worm. _Prinoxystus robiniae_, various flathead borers such as the Cypress heartwood borer, _Trachykele blondeli_, and various roundhead borers such as the pine heartwood borer, _Ergates spiculatus_, and the oak heartwood borer, _Xylotrechus nauticus_. The roots are injured by such root feeders as the roundhead, _Prionus californica_, and various white grubs of the family Scarabaeidae.

The methods of control vary as much as do the pests against which they are used. Some are direct and some are very indirect. Some give perfect results and some are great disappointments. As a rule the caterpillars are controlled easily by the use of arsenate of lead applied as a liquid spray. If they are hairy like the penstemon caterpillar it is cheaper and just as good to dust them with nicodust. If they are smooth like the California oak worm, this method is not reliable and the trees must be sprayed. Nicodust or some other tobacco product will control the aphids but the psyllids and scalers are more difficult. Many of the species have to be sprayed at just the proper time and often with just as strong an oil spray as the plant can stand. Careful pruning will control most of the twig girdlers. The barkbeetles are controlled by cutting out and burning the infested trees as in forest insect control. The best remedy for the bark borers is to cut out the individual borer at the proper time. The carpenter worm may be fumigated with carbon bisulphid placed in the mine, cut out when they are young or the tree may be caged and the moths captured or prevented from laying their eggs. The peach borer is either cut out or fumigated with paradichlorobenzene. Some varieties of shade trees and ornamentals which are particularly susceptible to insect injury are eliminated altogether, their places being taken by varieties of plants which are not so apt to be seriously injured by insect pests.

Shade tree problems are as important as forest insect problems. They may be even more varied and lead the Entomologist into contact with many more people. Some of them are solved quite easily and others are as difficult to solve as any of those met with in forest insect control. Good progress has been made in the work by the men of the Forest Insect Laboratory and as the California State Forester has taken Mr. Glendinning for the Highway plantings and the State Department of Agriculture desires Mr. Hartman for the nursery work we feel that the results obtained have been appreciated.

MR BURKE: Shade Tree Insects. Reads introduction regarding the planting of trees. Man planting trees for comfort, shelter, etc. Refers to comparison of shade and forest tree insects, regarding Government appropriations gipsy moth. Oak tree valued at $2000, has spent $500 on controlling borers and scales; within several years infestation shows up. California Oak Worm appears periodically from Bay region to L. A. Predicting infestation a problem; numerous moths appeared in June, no further notice however, Refers to black walnut being eliminated on account of aphids. Many trees on account of their insects involved are eliminated. Advice needing from shade tree entomologist. Nursery trees are planted and sold for profit. If trees are attacked and killed by insects and nurserymen had to realize a profit. Location of tree a factor on control, such as near valuable buildings. Highway planting now in rapid progress, cites Oroville and Chico grasshopper control; poison in this case not effective. Trees were saved by netting. Human nature a problem as to their manner of accepting insect control. City people are interested in shade trees.

MR EVENDEN: Discussion on shade tree. Elm scale control.

MR BURKE: Small tree water control best, larger trees not so effective. Spray on large trees not so practical. Spray when larvae are young.

MR EVENDEN: Regarding Wire-brush control

MR BURKE: Cite shade tree town with shadeless tree towns.

MR EVENDEN: Obtained successful control with garden hose as recommended by Burke.

MR PERSON: Refers to borer in ash, which is it?

MR BURKE: Could be moth, or roundheaded borers.

MR MILLER: Refers to Superintendent Fry of the Sequoia National Park whose young orchard was affected by borers.

MR BURKE: Fry's trees were white-washed with white-wash and poison after each rain. Refers to Chrysobothris mali importance in nursery rows. Best remedy is to cut them out with knife at certain times. Tree protector now being considered as a possible remedy. 80 plant families and many species attacked. Santa Cruz Mts. unable to grow red currants; also currant field at Hayward. Why does insect attack? Has come to conclusion they don't attack for any special reason except alcoholic attraction.

MR EDMONSTON: Believes the shade tree work is important. Hopes to keep the work intact.

MILLER: Should be taken up this afternoon. The shade and forest tree insect work is interlocking: has run into considerable work on this line, especially the last few years. Cites Arrowhead project as working as one organization. The two fields of work should be united for the betterment of the Branch as a whole. Something to think about for the reorganization this afternoon. This concludes the Forest Insect Conference. This P. M. will be on organization.

SPRUCE BUDWORM IN NORTHERN IDAHO

By James C. Evenden, Entomologist in Charge of
Northern Rocky Mountain Field Station, Coeur d'Alene, Idaho.

During the winter of 1921-22 a report was received at the Forest insect Field Station of the Bureau of Entomology, Coeur d'Alene, Idaho, from the Forest Supervisor, Kaniksu National Forest, relative to the drying of hemlock near Priest Lake, Idaho. In June 1922, Mr. Rust, Entomological Ranger, assigned to the Coeur d'Alene Station, examined this area and found that not only the hemlock but the larch, cedar, white pine, white fir, and Englemann spruce was being severely defoliated by a small worm or caterpillar. A number of these caterpillars ware collected and reared to adult moths at the Coeur d'Alene Station, which were then determined by Mr. Heinrich, Specialist of Forest Lepidoptera, Washington, D.C. as the spruce budworm.

The writer recorded the work of this insect on the Payette and Little Salmon River watersheds, and from reports submitted from Forest Officers during the past season it is very evident that this insect is fairly well established throughout northern Idaho. Mr. Heinrich, writes as follows: "It is somewhat doubtful how long the spruce budworm has been working in the west, but inasmuch as it is an American insect it is quite likely that it has been present there for a lòng time. It is now known from British Columbia to the southwest and most everywhere that hemlock and spruce occur." To the best of the writers knowledge this is the first authentic record which we have of a spruce budworm epidemic in the west.

The earliest record of a spruce budworm epidemic in the United States is given by Dr. Packard, in which he presents the possibility that the widespread destruction of spruce in the Casco Bay territory in 1807 was due to this insect. Dr. A. D. Hopkins, Forest Entomologist, U. S. Department of Agriculture, writes of the history concerning the known epidemics of this insect as follows: "In 1878 to 1885, an invasion of this insect swept over the New England and New Brunswick woods and aided by barkbeetles and disease caused the death of a large percent of the old spruce and fir. Then for about thirty years there was no evidence of its presence. Another outbreak developed in 1910, which continued its depredations in different areas throughout the north woods until 1921. Now it is claimed, by experts who have made a special study of the insect and its depredations in Maine and Canada, that from 25 to 75 percent of the merchantable or older fir and a somewhat less percent of the spruce has been killed in Maine, New Brunswick, and Quebec. Like the epidemic of about thirty years ago, the greatest abundance of the insects and the defoliation of the timber on any given area occurred during the first two or three years, after which the trees began to die and continued dying for five or six or more years, due largely to secondary causes such as root diseases and bark boring insects.".

The defoliation or attack by the spruce budworm is readily recognized by the blighted appearance of the new growth at the tips of the branches and twigs. On the heads of the Payette and Little Salmon Rivers, where the attack was the heaviest recorded, the needles of the new growth were stripped from every limb of the Douglas fir and white fir. With hemlock and larch the needles are fairly well eaten from the entire limb, while with white pine, Douglas fir, white fir, and englemann spruce the attack is apparently confined to the new growth at the tips of the limbs. This condition may be regulated by the severity of the epidemic and the abundance of the host material. During June and July if these limb tips are examined it will be seen that the needles of these are still held together by a few silken threads. In these loose masses the caterpillars are often found. Pupation also takes place within or attached to the outside of these nests.

Dr. Blackman writes of the seasonal history of this insect as follows: "The larvae are usually full grown during the first half of June and, still in their loose shelter of gnawed-off needles, transform to pupae. These, in the course of the next week or two, give rise to medium sized, brownish-gray moths, which in infested regions are flying in numbers during the last week in June and first half of July. The moths deposit their eggs in small light green masses on the sides of the needles. These eggs are flat and rather scale like, and are so placed that they form small oval masses which are so inconspicuous as to escape casual notice. The eggs are all laid before the last of July and ~~timmyxbx~~ the larvae from them hatch in a week or ten days. These minute larvae feed for a time, but perhaps only sparingly, and pass the winter as small partly grown caterpillars. It is in the spring and early summer that their appetite seems most voracious and when they do the greatest damage."

The future of this epidemic in Idaho is impossible to foresee. In the eastern part of our continent during epidemics this insect, assisted by barkbeetles and tree diseases, has been responsible for the destruction of an immense amount of timber. Furthermore, there is apparently no doubt but that in severe epidemics the spruce budworm can become independently destructive to the timber. During the summer of 1921 these insects were only in sufficient numbers as to attract attention in one small area. During the past season the epidemic increased in such proportions as to be reported throughout the northern part of the state. Should this condition continue for a number of years there is little doubt but that a large volume of timber will be destroyed as a result of the attacks of this insect.

Artificial control of this epidemic, which covers a tremendous area, is practically impossible because of the expense of the operation. To control an epidemic of forest tree defoliators it would be necessary to destroy a large percent of the worms, or caterpillars, by the application of a stomach poison to their food plants. The thoughts of applying this poison by spraying forest trees, aside from parks and wood lots are impracticable. The March 1922 issue of the National Geographic Magazine describes the successful treatment of a grove of catalpa trees in Ohia which were infested by a defoliating insect by showering poison dust from an airplane. This method seems the most feasible at this time for the treatment of forest defoliator epidemics and may in time become an economic possibility. However, as the use of air machines for low flying over mountainous regions would be an extremely hazardous occupation, this

method is hardly feasible with our present equipment. It is possible that a large percent of the loss incurred during these epidemics could be prevented by the controlling of other insect attacks.

Though as yet none have been repdorded by the officers of this station it is hoped that these insects have natural enemies, or that there will be some natural influence that will check this epidemic. In the past the continuance of epidemics of the larch sawfly, pine butterfly, hemlock looper, and other defoliating insects have been prevented by natural agencies, and it is upon this hope that the cessation of the spruce budworm outbreak in Idaho depends.

WHITE PINE BUTTERFLY EPIDEMIC IN IDAHO.

(Neophasia menapia)

By
James C. Evenden.

During July 1922, the writer was advised by Mr. H. C. Shellworth, Boise-Payette Lumber Company and by Forest Officers of the Payette and Idaho National Forests, of a severe defoliation of the yellow pine on the Payette and Little Salmon River watersheds. Caterpillars were submitted to this station which were identified as the pine white butterfly (Neophasia menapia, Felder)

The writer visited this region in September 1922, where considerable time was spent in an examination of this epidemic. The defoliation covered an area of approximately 30,000 acres. This area was not in one block but was distributed in five centers of infestation located at New Meadows, Mc Call, Sphinx, Arling, and Clear Creek. The work of this insect was recorded in other regions but not with the same severity as in these five centers.

In these five areas the defoliation had been very severe, all of the old needles, prior to the 1922 growth, had been eaten off to within ½ inch or more of the limbs and in many instances the new needles had been injured. Where the needles are eaten close to the limbs the fascicles soon dies and falls. This damage was not confined to the mature trees as a large percent of the reproduction was severely defoliated.

It is reported that during August immense clouds of these butterflies were to be seen in this region. This fact is readily believable as millions of their dead bodies were to be seen upon the forest floor. Apparently the main flight of these insects occurred at that time. At the time of the examination this insect was in the egg stage, large numbers of which could be found upon the remaining green needles of both large and small trees. It does not seem that there can be any doubt but that the winter is passed by this insect in the egg stage. Though this insect has been known for many years its seasonal history has never been determined.

Records are known of other epidemics of this insect occurring in the northwest on the following dates: 1882, 1883, 1890, 1894, 1895, 1896, 1903 and 1917. With the knowledge that it is almost impossible to foresee the acts of nature, yet based upon the history of other epidemics it is believed that this infestation will be controlled by natural agencies before the insect itself becomes independently destructive to the timber. In this connection a fairly large percent (15 to 20 percent) of the caterpillars which

were present during June and July failed to reach the butterfly stage due to predacious and parasitic insects.

Though it is believed that the pine butterfly will not be directly responsible for the death of any great amount of timber, the defoliated trees must be severely weakened and their resistance to insect and fungi attack greatly reduced. Just what effect this condition will have upon the normal Dendroctonus brevicomis infestation which is present throughout this region is unknown.

COLORADIA PANDORA, Blake

ORIGINAL NOTE:

By
J. E. Patterson.

Hopk: 16241 - Pinus ponderosa and Pinus murrayana, Headwaters of the Williamson River and Upper Klamath Marsh, Klamath Indian Reservation, Oregon. Long: 121 deg. 30 Min. W. - Lat: 42 deg. 50 Min. N. Elevation 4800 feet. August 24, 1921. J. M. Miller, J. H. Pollock and J. E. Patterson collectors.

a - Lepidopters - Pupae of large defoliator collected in soil under and around host trees. These pupae were naked and were burried from 1 to 3 inches below surface of soil which was composed of loose volcanic ash. The damage to the hosts consists of defoliation caused by the caterpillars eating the needles to within one-half inch of the petiole. In areas of heavy defoliations, where conditions indicate that the epidemic has been present for some years, from 50% to 90% of the needles have been stripped from the trees. It was noted that the caterpillars do not feed on the new needle buds. The prevalence of the insect was shown by finding 84 pupae in an area of ground ten feet square.

b - Diptera - Puparia collected from soil in pipal beds of a - . These are probably parasitic on a- They were collected wherever a- was found.

c - Diptera - Parasite of a- Larvae found in dried host larvae and pupae.

REARING NOTES:

A part of the original material collected (40 pupae of a-) was sent to Washington, D. C., for attention of Mr. Carl Heinrich. The rest of the material was caged at Jenny Creek, Oregon, on August 30, 1921. The material was placed in a rearing tray 20 x 30 inches square. This tray was constructed with a copper mesh screen bottom and a wire mesh screen lid. About 4 inches of soil brought from the locaility where the insects were collected was dumped in this tray. The pupae were placed in this soil from 1 to 3 inches below the surface. The tray was then placed in the open woods to secure, as near as possible, the same conditions that prevail in the native habitat. The elevation at Jenny Creek is slightly under 4,000 feet.

During the balance of the fall of 1921 the cage was examined from time to time without noting any activity on the part of the insects within.

May 10, 1922. - Examined the material and found that a number of the moth pupae had died. A few adults of b- had emerged and were collected from the cage.

June 20 to 20. - A number of adults of a- emerged during this period. They were fed sugar water in the cage and lived for 4 or 5 days after emergence. This would appear to be a trifle early for the species to emerge but may be accounted for by the material being at a lower elevation than in the locality where it was collected. Adults were reported flying on the Reservation during July and I observed straggling specimens flying in July at a number of places west of the Klamath Lakes. Individual adult specimens were collected at Round Lake, Aspen Lake, Clover Creek, Oatman Lake, Mill Creek and Jenny Creek. From this it would appear that there is a light infestation throughout this territory or else stragglers strayed far from the epidemic area on the Klamath Reservation.

HISTORY OF THE INFESTATION

The history of this insect on the Klamath Reservation up to the spring of 1920 is clouded in more or less obscurity. The following short account is from Mr. F. Marion Wilkes, Forest Topographer to the Indian Service, who has been detailed on topographic work on the Klamath Reservation and has worked on and in the vicinity of the infested areas since 1918. Mr. Wilkes is personally known to the writer as a careful observer and a very capable woodsman of naturalistic inclinations. Therefore his observations and findings are of great scientific value and accuracy. According to him the Indians are and have been familiar with the insect for a long period of years. In years past the pupae of the moth was an article of food with the Klamath and Modoc tribes of Indians and was considered a delicacy when roasted. The Indian name for the pupae, as verified by Mr. Wilkes, was "Bull Quanch." The younger generation of these indians know very little about the insect as they are far removed from the tribes' aboriginal customs and manner of living.

The information that Mr. Wilkes obtained from the older Indians was to the effect that the insect appeared at intervals of about 20 years separation but when it did appear persisted for 3 or 4 years in continuous epidemic. As near as could be ascertained from this source the last epidemic preceding the present occurred about 22 years previous to 1919.

So much for past history: The authentic history of the present epidemic starts in the spring of 1921 when Mr. Wilkes reported large numbers of caterpillars on the yellow pines near the mouth of the sprague River in the vicinity of Chiloquin. The timber here was being greatly defoliated. Later during the same season (August 1920) the writer met in Algoma, Oregon, Mr. W. J. Chamberlin, of the Oregon Agricultural College, who had just returned from a field trip into the forests south of the Sprague. He reported a great flight of moths in this locality; also large areas of defoliated trees, He had collected a large number of adult specimens on this trip. During the same month the writer collected a few living specimens on Jenny Creek, Oregon. In April, 1921, the writer in company with Mr. Chas. W. King, made a trip into the Reservation to examine the timber on the headwaters of the Williamson

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River. During this survey a large body of defoliated yellow pine was examined a short distance north of Calimus Butte. Many empty pupal cases of the moth were found on the ground in this area but no living insects were seen. A few days later some small, dark green, Lepidopterous larvae were found attacking yellow pine needles on trees in the vicinity of Riggs Springs. These larvae were undoubtedly young Coloradia. At this time the larvae of the insect would be very small as winter conditions still prevailed. Later during the season of 1921 (in August) the writer in company with Mr. J. M. Miller and J. H. Pollock visited this same locality and collected a large number of pupae in the defoliated areas. The entire generation was in the pupal stage at this time. Mr. King, who had been conducting light burning operations on the Long-Bell Reservation Tract during the previous part of the summer, reported that great numbers of the caterpillars had been feeding on the needles up to ten days previous to our visit on August 20th.

After examining the defoliated areas in this vicinity of Riggs Springs the party went to Mr. Wilkes, who stated that the severest defoliation he had observed was in Twp. 31, R. 9E., adjoining the Klamath Marsh. In company with Mr. Wilkes the party visited this area and made a careful examination of the damage here. This examination confirmed Mr. Wilkes previous statement. The yellow pine trees on this area had suffered severely; to the extent that perhaps 90% of the previous two years crops of needles had been eaten. The prevalence of pupae under the trees also showed that the area was more heavily infested than any other area which had been examined.

Unfortunately, owing to the pressure of other work, the writer was unable to visit these areas again in 1921 or at any time during the season of 1922.

THE MOTH

Description:

Adult: General color brownish gray; antenna pectinated, yellow; Thorax and abdomen above, brownish, clother with soft hairs, sides grayish with hairs. Apex of abdomen tufted; Forewings above brown with gray scales, a small black spot on the disc, below, pinkish gray. Hindwings same color as forewings, also with dark spot on disc. Cilia whitish. length of body, 40 mm, 35 mm Expanse, 90 mm, 70 mm.

Eggs: Pale bluish green in color. Semitransparent when deposited; later becoming dull green and opaque. They are approximately 2.5 mm. long and 2mm. in width. They are deposited in clusters of a few eggs to 60 on the trunks of the host trees.

Larvae: The full grown larvae or caterpillars are over 45 mm. in length and are geenish in color. The young larvae are dark green to brown with black head and thoracic shield.

Pupae: The pupae are brownish black in color. They are found from 1 to 3 inches below the surface in loose soil. There is no cocoon, the pupae being naked and inclined slightly from the veryical with the head up.

LIFE HISTORY.

The data in hand to date indicate the following partial life history of the species in this locality. Attention is called to the fact that our records are as yet far from complete; therefore subsequent work and observations may give additional data which will clear up some of the present more or less obscure phases of the insects developments and habits.

Adults emerge and fly during July and August of alternative years,

Eggs are deposited during the flight period. They are placed in the crevices of the bark on trunks and limbs of the host trees and occasionally in the debris on the ground surrounding the trees. So far we have not definitely determined whether the eggs hatch during the season of deposition or early in the following spring. It is believed that they hatch the same fall that they are laid as small larvae were found feeding on the foliage in April 1921.

The larvae or caterpillar stage lasts from hatching of the eggs until midsummer of the following year. During this period they feed on the needles of the preceding two years growth, but do not attack the young needles of the current years growth.

Pupae begin forming in July and by August 20th the entire generation is in this stage. The pupal stage lasts until July of the next year when flight again occurs.

From the preceding it will be observed that the life cycle covers a period of two years. Flight occurring every alternative year. This is graphically shown by the accompanying chart.

NOTE: Mr. A. J. Jaenicke found young larvae, approximately 10 mm long, feeding on the terminal shoots of pine trees in the vicinity of Wocus Marsh, Twp. 31 S. R. 9, Klamath Reservation, in early September 1922. The young caterpillars were dark green in color with large black thoracic shields. This note, which was received from Mr. Jaenicke after this memorandum was written, is of great value in showing that the caterpillars hatch the same season that flight occurs.

HABITS AND DAMAGE

The larvae in this locality feed on the needles of yellow pine (Pinus ponderosa) and lodgepole pine (Pinus murrayana). It has not been found to feed on any other species. Its habit of feeding on lodgepole pine appears to be purely accidental; therefore it may be said that the insect is primarily an enemy of yellow pine. Its attacks are confined to the mature or nearly mature needles, very rarely attacking the buds of the new growth or the very young needles. This habit, coupled with its two year life cycle, offers the host trees breathing speels in which to recover from nearly complete defoliations made during the feeding periods of the larvae.

The primary damage to the attacked trees consists of weakened vitality through the loss of needles during the periods of the trees growth. To the knowledge of the writer this damage has not, in any case, resulted in the death of attacked trees. However, it is quite possible that many of the defoliated trees may fall victims to barkbeetles or other tree killing insects for owing to their weakened condition these trees could not repel even a light attack made by any species of these insects. This is a contingency which deserves attention for it is known that there is at the present time an epidemic of Dendroctonus brevicomis in the adjoining pine timber to the south and east of the defoliated areas. This adjoining infestation is a menace which may result in an invasion and consequent extensive killing of the defoliated stands.

DISTRIBUTION

The known distribution of the present epidemic covers an area of about 12 townships located approximately in the center of the Klamath Indian Reservation. The boundaries of this area may be roughly drawn as follows: From Calimus Butte east to the Sycan River, thence up the Sycan to Long Creek, up this creek to its source, thence to Yamsay Mt. and down Deep Creek to the Williamson River, following down the latter to the Klamath Marsh, thence south to Calimus Butte.

Infested areas south of the Sprague River have been reported. Through the writer has not been on these areas it is believed the reports are authentic.

Individual specimens of living moths have been collected throughout the pine timber in the entire Klamath Basin. However, the insects work or damage has not been discovered in this region outside the Klamath Reservation.

The present known distribution is shown on the accompanying map.

NATURAL ENEMIES.

The known natural enemies of the pandora are few. The degree of natural control which they exert has not been determined. Two Diptera of the Tachinid family have been determined as parasitic on the caterpillars. These species are as yet undetermined.

Small Rodentia: (Sciurus and Spermophilus) are known to prey on the pupae. Many caches made by chipmunks (Spermophila) have been found in the infested areas. Some of these caches contained as many as 90 pupae. The rodents dig the pupae from the soil leaving short burrows 1 to 3 inches deep as evidence of their activities. 40 of these burrows were counted in one area of 10 feet square.

ARTIFICIAL CONTROL

The ordinary methods of artificial control, such as spraying the trees with contact or stomach poisons or collecting and killing the pupae, are not practicable on large forested areas such as are found in these infestations.

An alternative method, which is believed would be effective, consists of direct attack by the use of fire during the feeding period of the larvae, This method in application would involve the following procedure: Ground debris fired and burned on the ground under the infested trees would cause the caterpillars to fall to the ground as a result of stuperfaction induced by the smoke and gases ascending through the trees from the fires. Many of the caterpillars would fall directly into the fires and die; those which fell outside the fires could be raked in with an ordinary garden rake.

This method is known to be effective to an undertermined degree as it was unintentionally applied by Mr. King during forest light burning operations carried out on some of the infested areas during the summer season of 1921.

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